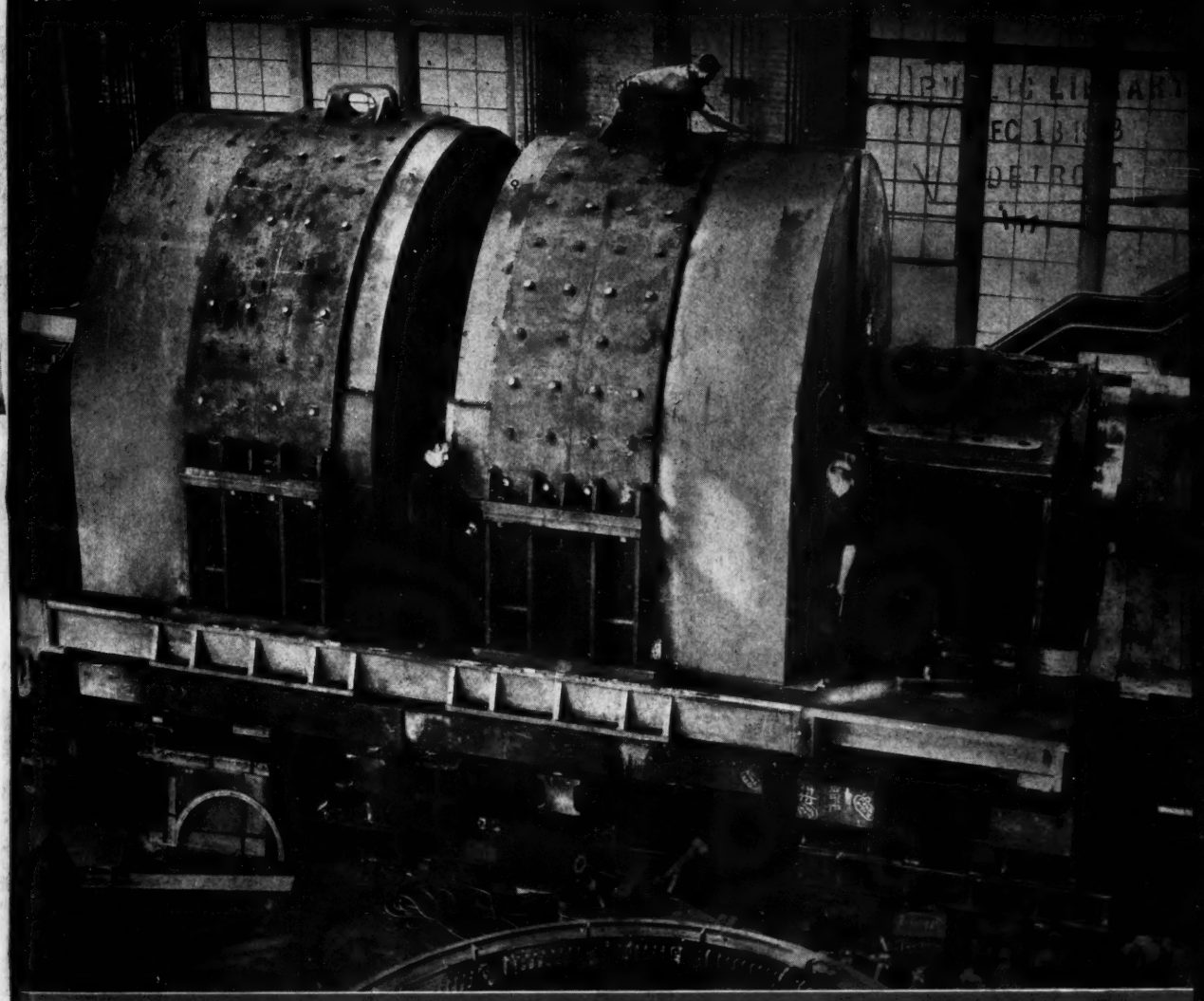
POWER PLANT ENGINEERING

THE POWER ENGINEERING AND MAINTENANCE MAGAZINE FOR EVERY INDUSTRY



Monsanto's New Boiler Plant

Don'ts in Designing Coal Handling Equipment

Feed Pumps—Constant or Variable Speed?

Yearly Index • Electronics Today and Tomorrow

Turbine Blade Deposit Removal

DECEMBER
1943

ELLIOTT
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COMBAT TEAM
on the power front—

They call them "combat teams" on the fighting front, these coordinated units of tanks, planes, artillery and infantry, organized to work closely with each other as a single fighting group, to the extreme discomfiture of the enemy. It's an American development, and a very successful one. Its basis is teamwork, American style.

You'll see it illustrated in power plants, too. The photo shows a typical one—an Elliott condensing turbine-generator unit. The turbine, designed to the job with extraction points to suit the most economical heat balance, works hand-in-glove with its highly efficient Elliott-built generator. The Elliott surface condenser is designed from hotwell to steam dome exactly to serve the needs of the Elliott turbine above it. The condenser is served by an Elliott ejector and has Elliott turbines and motors driving the circulating and condensate pumps.

Included on the Elliott team in this plant is a deaerating feedwater heater. It uses steam extracted from the main turbine to heat feedwater to saturated steam temperature and by deaeration it protects the boiler system from oxygen corrosion.

The whole set-up is a coordinated unit for economical power production and is the exact counterpart of the combat teams that are showing the Nazis some new angles on warfare.

The combined unit in the photo is of 6000-kw capacity, typical of many which are making the Elliott monogram a synonym for dependable performance in power plants serving war industry in many localities.

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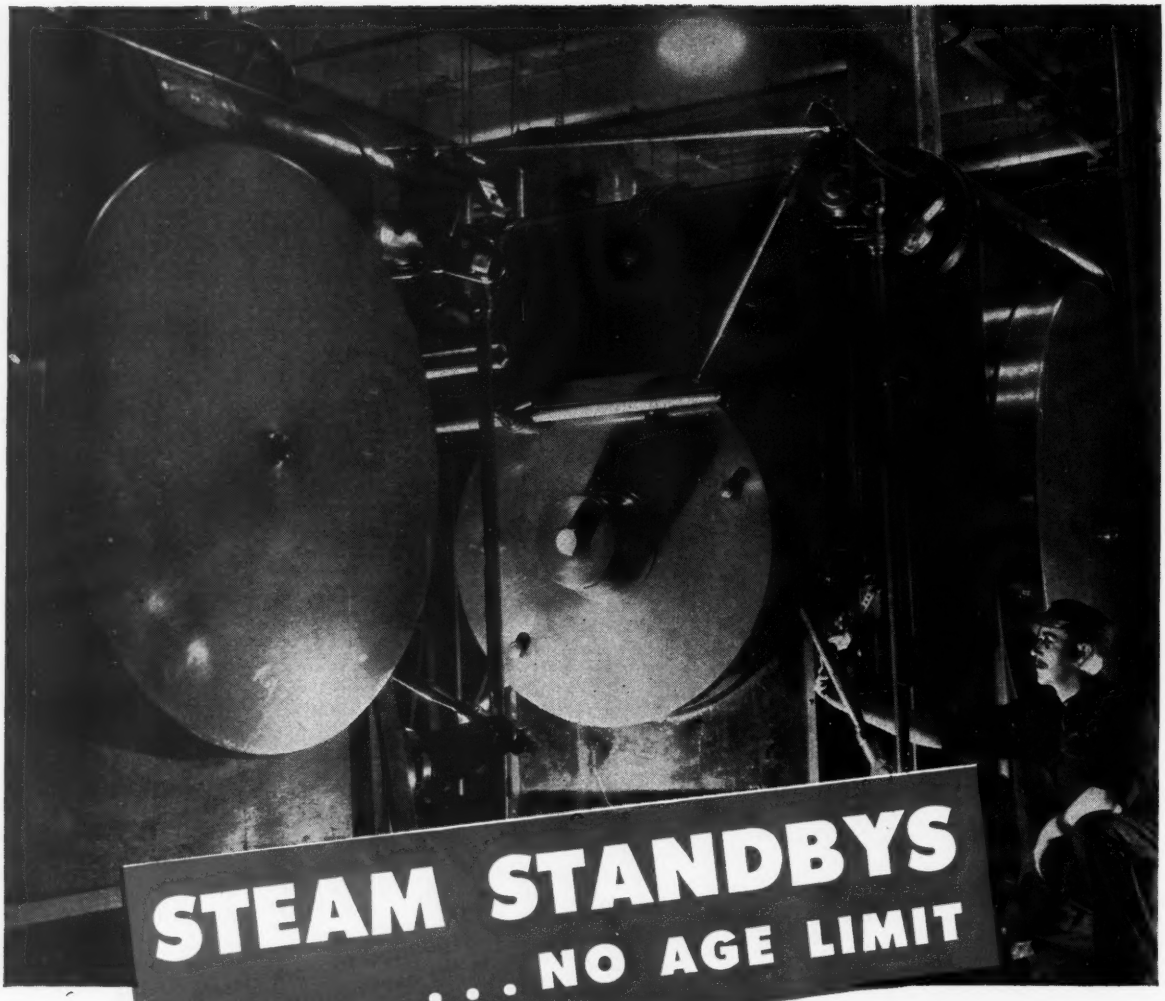
...ther has been added to ...e Army-Navy "E" flags ...own by both the Jean- ...ette and the Ridgway ...nts of Elliott Company.

Q-1097



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Contents, December, 1943

VOLUME 47—NUMBER 12

Cover: Largest motor in the world. General Electric, roughing-mill double reversing d-c motor built for the 132-in. semicontinuous plate mill of the Geneva Steel Co. at Geneva, Utah. This motor is rated at 7000 hp, 25/60 rpm, 700 v. It consists of two units connected in series, 3500 hp, 350 v, 20 poles. See also page 124.

Front Lines 7
What Leaders Say 63
Better Than Copper 64
With the Editors 65
Monsanto's New Boiler Plant at Springfield, Mass. 66
Electrical Energy Is Elusive 70
Don'ts for the Designer of Coal and Ash Handling Installations .. 71
By Wilbur G. Hudson
How to Select, Install, and Maintain Electric Motors 74
By O. F. Vea
Turbine Blade Deposits, Prevention and Removal 79
By Ralph E. Turner
Water Conference 83
Industrial Electronics Today and Tomorrow 84
Motor-Driven Boiler Feed Pumps—Constant or Variable Speed? 88
By Igor J. Karassik
Dust Collectors and Non-Critical Material 92
By Louis C. Whiton
Joint Fuels Conference 96
The Practical Engineer and Electrician 97
What Happens When You Weld Steel? 124
World's Most Powerful Motor 126
Our Dwindling Oil Resources 128
Saved—850,000 Pounds of Tin 142
New Equipment 146
Obituaries 162
Manufacturers' Personals 164
Manufacturers' News 168
News from the Field 172
New Engineering Books 190
Helpful Bulletins 191
Power Plant Construction News 202
Annual Index of Power Plant Engineering 207

Contents of back issues of Power Plant Engineering will be found in Industrial Arts Index on file in Public Libraries.

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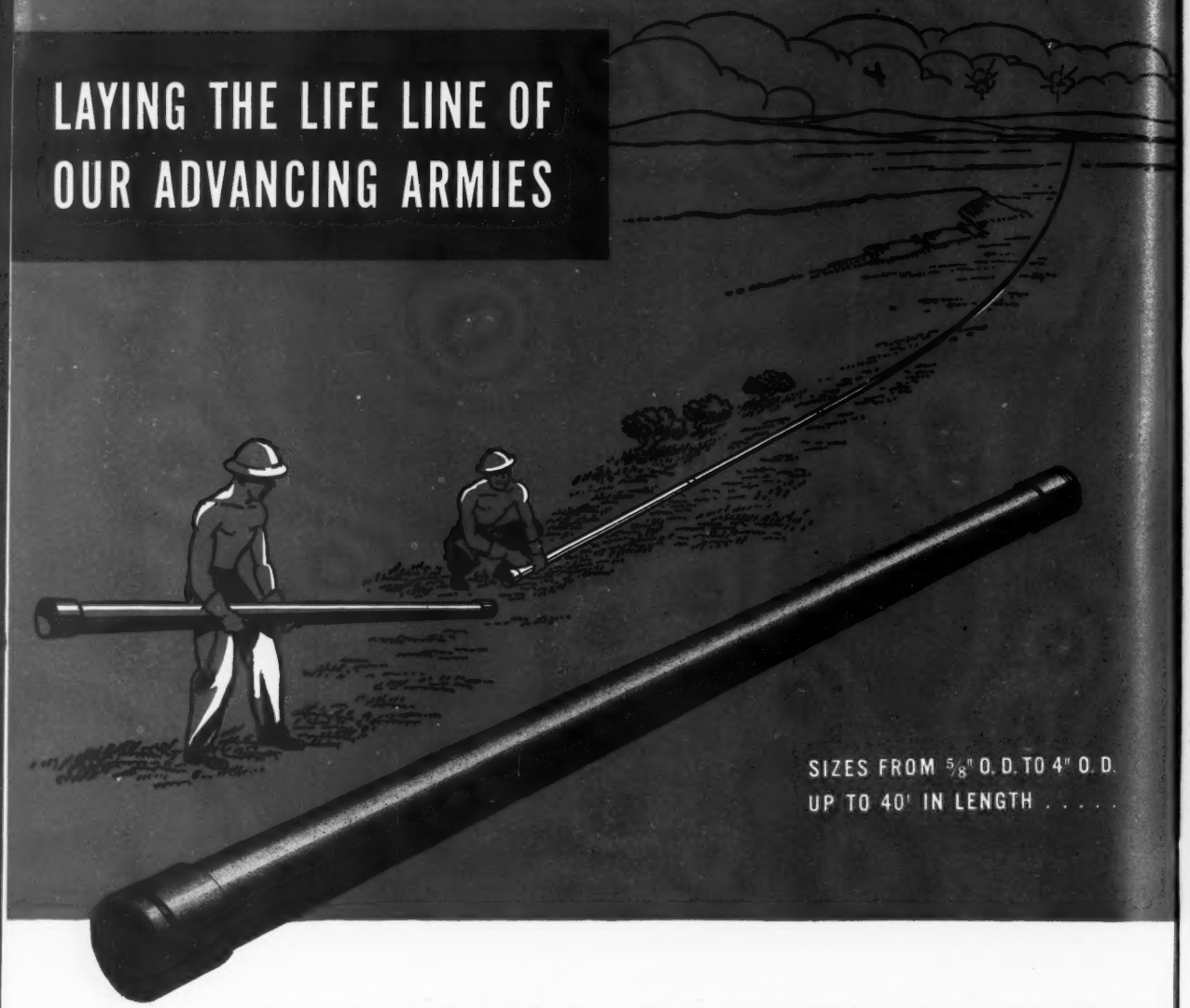
LAYING THE LIFE LINE OF OUR ADVANCING ARMIES



Many miles of Talon's Electric Welded Steel Tubing connect supply bases with combat areas. Known as "invasion lines," these vital arteries carry the "blood stream" of our mechanized forces—gasoline, oil, and water. Each type of product flows through separate 4" lines at a 6,000 bbl. daily rate. The requirements of such installations are light weight for ease and speed of placement in the field, and great strength to withstand the shocks of battle. Talon's tubing is successfully passing this rigid test.

The lines are laid in 20' sections, each weighing only 70 lbs. The light weight enables a skilled crew to lay up to 10 miles per day. Extra heavy nipples are welded onto the light wall tubing for coupling in the field. Another indication of the great strength of Talon's tubing—the lines follow natural contour of the land without trenching.

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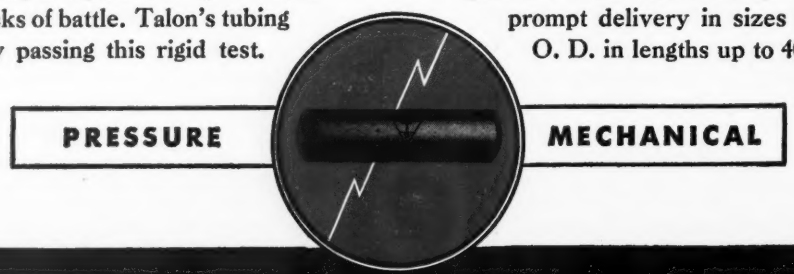

TALON . . INC.

STEEL TUBE DIVISION — OIL CITY, PENNA.

FRONT LINES

OUR GOOD FRIEND, Ambitious Al, came in the other day and sounded off again. Last month, you remember, he sounded off about post-war planning in the Letters & Comments section of P. E. & E. This time it was about all the windbag politicians and starry-eyed dreamers who are always talking about the "little people" and using Henry Wallace's term "the common man" with a tone of condescending superiority that Mr. Wallace never intended it should have. But Al's principal beef was about the "little people" and the $40,000,000,000 of "inflationary gap" they are alleged to be piling up to ruin the country with if they try to spend it. "Listen", said Al, "people aren't so dumb as a statistician can prove they are. They know, far better than all the statisticians, what inflation and depression mean. They're saving that money for a rainy day, when all the war jobs disappear and the big shots of industry are running around helpless, spouting about the laws of supply and demand. Or they want to save it for a trailer or a summer camp or something to act as an anchor to windward. Where do you suppose the banks are getting all the money they put into War Bonds?" Al started to go, then turned back. "By the way", he said, a gleam of something in his eye, "let me know if you see a good unused inflationary gap lying around loose. I could use it to pay the grocery bill and the dentist."

THE FIRST CONVENTION by radio was that of the National Association of Foremen, broadcast over the Blue Network on September 25. We heard parts of it and thought it went pretty well. It is, of course, only one more step from this to television conventions. In the present circumstances, the radio convention was devised to save time, transportation, fuel, etc. A meeting of foremen was held in Dayton, Ohio, the national headquarters of the Association but it was attended only by men from that city and vicinity and by the various invited speakers who included Charles E. Wilson, Paul G. Hoffman, Louis Ruthenburg, Arthur C. Horrocks, Charles Perelle. Each talk was short and entertainment features were inserted in the program. Here is an idea that the engineering societies would do well to study. It has only one defect: to the average engineer, the convention offers a chance for an interesting trip to a big city, a chance to meet old friends, see new plants perhaps and get out of his own little whirlpool for a while and get some new ideas. He can read all the technical papers later, in the journal of his society and the engineering magazines.

EVERYBODY and his brother has been taking written examinations of one kind or another during the past year or two. It is not surprising, therefore, if some people begin to feel, as a friend of ours put it, that the taking of examinations has become an industry all by itself. If that is true, then certainly there should be a textbook to cover that industry and behold! there is such a textbook—"How to Pass a Written Examination" by Harry C. McKown. All kidding aside, there is a very definite technique that will aid tremendously in passing written examinations. Those who have had to take very many of them have had to work out this technique more or less independently, but a number of factors in it seem to be quite common. Of course, if you know the subject thoroughly you don't need much technique. There will always be much debate as to the correct procedure of preparing for a written examination—whether to relax the night before by going on a terrific binge or whether to stay up all night hitting the book, sustained by gallons of black coffee. As to the taking of the examination itself, we won't give away Mr. McKown's directions on procedure but we think they would be recognized and approved in the main by the type of person who is in the habit of passing written examinations. There is, of course a type of individual that seems to have a natural aptitude for failing written examinatons. For such individuals, we regret to say, neither Mr. McKown's book nor any other will give much help.

IN HIS INTERESTING ARTICLE, Can The Small College Survive? in the S.E.P. of October 16, Felix Morley, President of Haverford College, among other things, points out several characteristics of the current Army and Navy educational program which he says are close to being the ingredients of a prescription for the academic malaise from which so many of our small colleges have been suffering. He is, of course, referring primarily to the liberal arts college but the engineering colleges as well may benefit by some careful thought about these things. Mr. Morley points out that "The service programs are uncomfortably exacting in their scholastic standing. . . . These programs are intensive; there is little opportunity for that dispersion of study which is one aspect of over-elaboration in our colleges. At Haverford, for example, the Army forces trainee will take as much mathematics as is habitually studied by their majors in that subject up to their senior year." . . . . . "The discipline in the service programs is not merely intellectual. The austerity of this training may be a useful corrective to the slipshod, slovenly attitude that many a prewar undergraduate mistook for sophistication. The outstanding characteristic of the service programs, however, is their underlying permeating democracy. The showing made by the man himself is the sole criterion" and is not affected by social and economic factors. In our engineering colleges, so far as insistence on the rigorous honesty of engineering thinking is concerned, there is very little to criticize. The idea of both intellectual and physical discipline is not strange to engineers nor to the great majority of engineering students, nor is it unusual to judge an engineering student on the basis of his technical ability rather than the size of his father's bank account. The contrast between the attitudes of the average student in an engineering school and in an academic department is often startling to outsiders. But perhaps the engineering school could do something with that factor of intensive training with which the service programs are having so much success at present. In doing this, however, they

must not forget that the primary purpose of the Service Programs is training in specific skills, not necessarily engineering education. We are very much afraid that a great many of the boys who come out of the services after the war thinking that they have had engineering education are going to be sadly disillusioned. Most of them will have nothing but a smattering of technical skills. Besides, the more we see of engineering the more we are convinced that they need less technique and more of the things the liberal arts colleges can give—thorough grounding in mathematics, physics, mechanics, language—yes, and philosophy, history and even astronomy.

DURING a recent editorial trip, we heard many expressions of interest in the subjects announced for discussion at the 1943 Annual ASME meeting, such as the Twin-Branch 2500-lb installation, new discoveries in feedwater treatment, graphitization of steel piping, new methods of burning coal. Many of the engineers with whom we talked felt it was just plain bad luck for them that, just when they most need all the information they can get through talking with friends and listening to the discussions at this important meeting, it is a most difficult time to have it occur, and many of them who would attend in normal times will be unable to go this year. For that reason, we shall cover the important topics of the meeting as fully as possible in the January issue, since most of the preprinted papers were not announced nor available as this issue goes to press.

NEW TYPES of lamp batteries have been developed during this war that shoot ultraviolet Vitamin D rays at navy crews, especially those aboard aircraft carriers who work below decks, in fire rooms, shops and the like. This is an extension of the application of the "lighthouse" type lamps that have been used in a few industries for irradiating groups of 15 workmen at a time.

THE OPERATING RATE of steel companies having 94 per cent of the steel capacity of the industry was 100.6 per cent of capacity for the week beginning October 25, compared with 100.7 per cent one week ago, 100.8 per cent one month ago and 101.1 per cent one year ago. This represents a decrease of 0.1 point or 0.1 per cent from the preceding week. This week's operating rate is equivalent to 1,753,400 tons of steel ingots and castings, compared to 1,755,200 tons one week ago, 1,756,900 tons one month ago, and 1,729,500 tons one year ago. Now please don't ask us how they can be operating at 100.6 per cent of capacity —we don't know. We're asking the American Iron & Steel Institute, which gave out those figures.

THE LIFE OF ITS LIGHT . . is only one second, yet so short is each flash that it can take 1,000,000 individual photographs! "It" is the 1000-watt Mazda mercury lamp in General Electric's new "speed-light" camera. The device, says G-E News Digest, consists of a small box weighing less than 25 lb. The light source is on the front, like a small headlight, and can be operated manually with a pushbutton or automatically by electrical contacts or phototube and preamplifier. An ordinary 115-v a-c household lighting circuit is used to operate the unit. The lamp itself is about the size and shape of a cigarette and will illuminate 20 sq ft of area brightly enough to photograph the fastest moving objects. In tests, photographs have been taken of a wheel revolving at 70,000 rpm. Use of the unit so far has been confined to studying high speed machinery, such as turbine and supercharger parts.

DEPARTMENT OF LIBERAL EDUCATION in the House Organs in 15-Min a Day: Steel Barrels—details of their manufacture, applications and how to take care of them properly, illustrated with very good photographs. Life-Savers—good pictures of the equipment used in making them. Oil Power, September-October, 1943; Socony-Vacuum Oil Co., Inc. * * * Construction details of Foster-Wheeler twin-furnace separately-fired superheater type of steam generating units, the seventh of which has just been installed. Cooling Towers in Bingham Canyon—details and photos of construction of towers for great copper producing center. Twenty-four Miles of Condenser Tubing—the new unit at Trinidad Station of Texas Power & Light Co. Heat Engineering, May-June, 1943; Foster Wheeler Corp. * * * Sprayed Metals Are Finished by Grinding—details of procedure with good photographs. Grits and Grinds, September, 1943; The Norton Company * * * Wooden Towers Make Unusual River Crossing—well-illustrated description of an unusual job on the Merrimack River; Contact, November, 1943; New England Power System * * * Pullman on the March—the kind of cars you'll ride in after the war; Central Manufacturing District Magazine (Chicago) November, 1943 * * * Application and Maintenance of Edison Alkaline Industrial Truck Batteries; Storage Battery Power, October, 1943; The Edison Storage Battery Division of Thomas A. Edison, Inc. * * * Refloating the Ex-Liner Normandie—complete detailed description, with more of those fine Navy photos, also good diagrams. Paving with Soil and Cement—a new technique that might be useful to the power engineer at certain times, well illustrated to show the procedure. Compressed Air Magazine, November, 1943 * * * Causes and Prevention of Furnace Explosions; The Locomotive, October, 1943; Hartford Steam Boiler Inspection and Insurance Co. * * * Molding Instrument Panels by Printing Plate Process; Bakelite Review, October, 1943; Bakelite Corporation * * *

FOLLOWING the coal strike during the first week of November, which has resulted in an estimated loss of production of about 12,000,000 tons of bituminous coal, the Solid Fuels Administration for War is revising its plans for coal deliveries. The expected revisions will leave the electric utility industry in at least as good a situation as it held under the former plan of coal delivery and storage but will probably have more effect on industrial users. Leaving out of account metallurgical coal, including that for manufactured gas, required by power utilities only in relatively limited quantities, such utilities having 45 days' supply or more, will be allowed to buy only 75 per cent of their monthly burn during the first month the order is in effect. During the second and subsequent months, utilities with a 60-day supply will be allowed to buy only 75 per cent of their monthly burn. Industrial users will be allowed to buy their full monthly burn and, in addition, enough to bring them to 30 days in two months if they have less than 30 days' supply, otherwise they may buy only 75 per cent of the monthly needs. It is expected also that OWU power supply engineers will work out plans considering both area power supply and fuel supply to prevent shortages of power due to variations in fuel distribution.

TWO BIG REASONS

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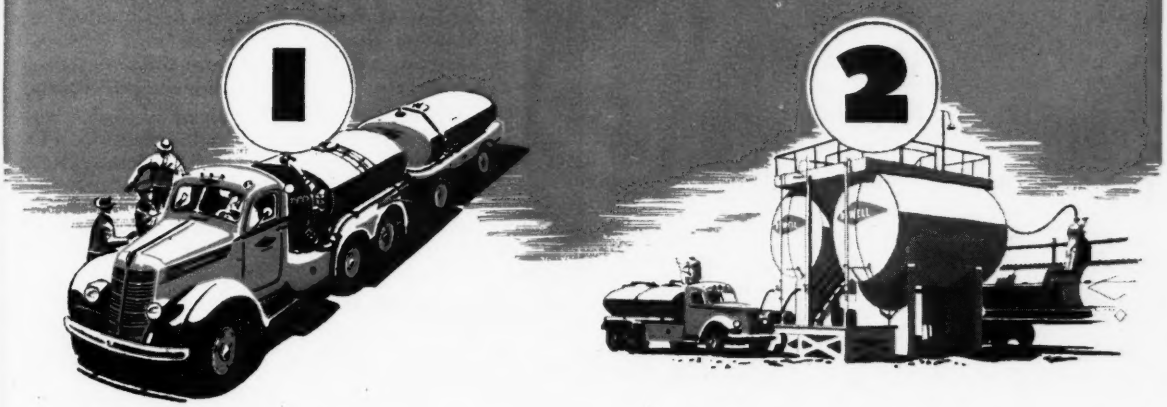

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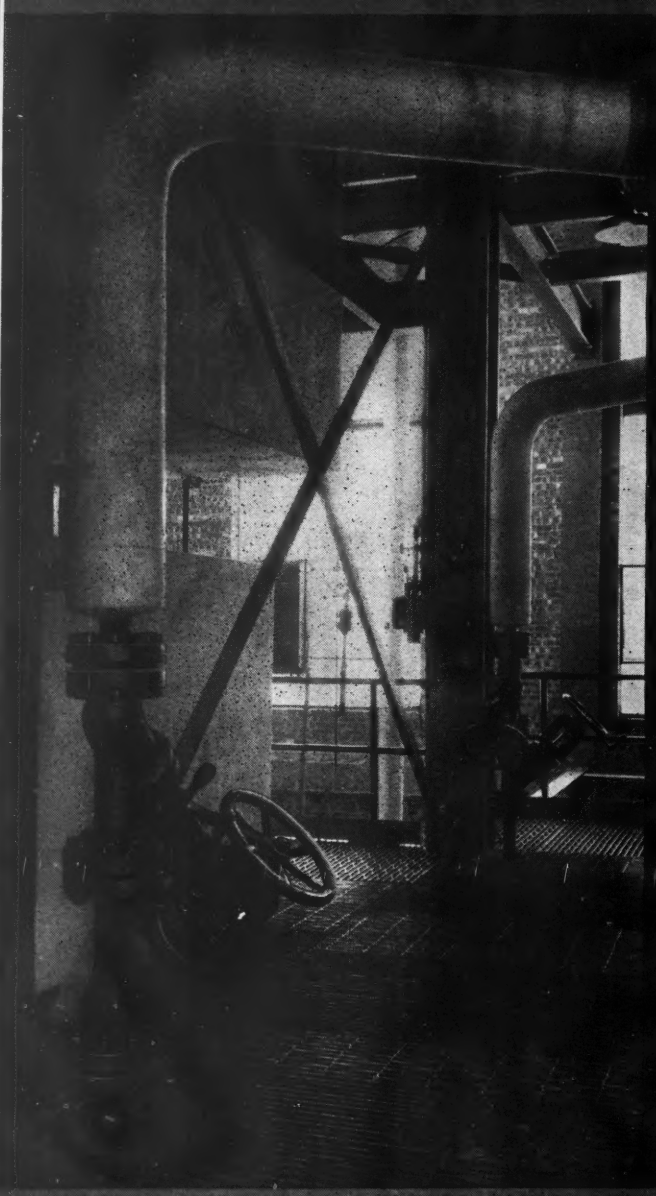

AT Phelps Dodge Corporation's great Morenci, Arizona, copper mining enterprise, Yarway Seatless and Hard-Seat Blow-Off Valves—112 of them in all—are used in tandem on both the direct-fired and waste-heat boilers.

The high pressure, direct-fired boilers in the power plant utilize 40, 1½ inch Tandems, Fig. No. 4932-3932 for pressures up to 1500 lb. The waste-heat boilers, operating on heat from the smelter, utilize 16, 2½ inch Tandems of the same type.

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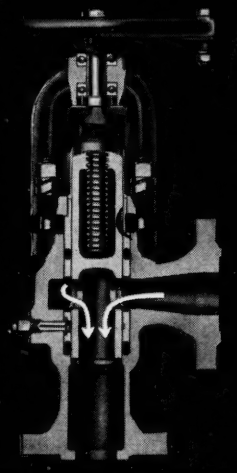
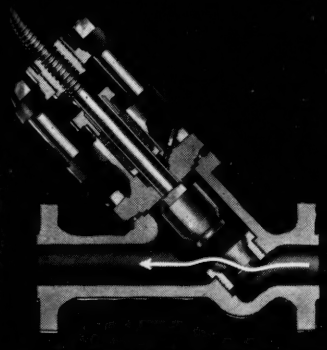


The Yarway Seatless Blow-Off Valve with no seat to score, wear, leak. Used as the sealing valve of the Tandem.



The Yarway Hard-Seat Blow-Off Valve with special Stellited seat and disc. Used as the blowing valve of the Tandem.

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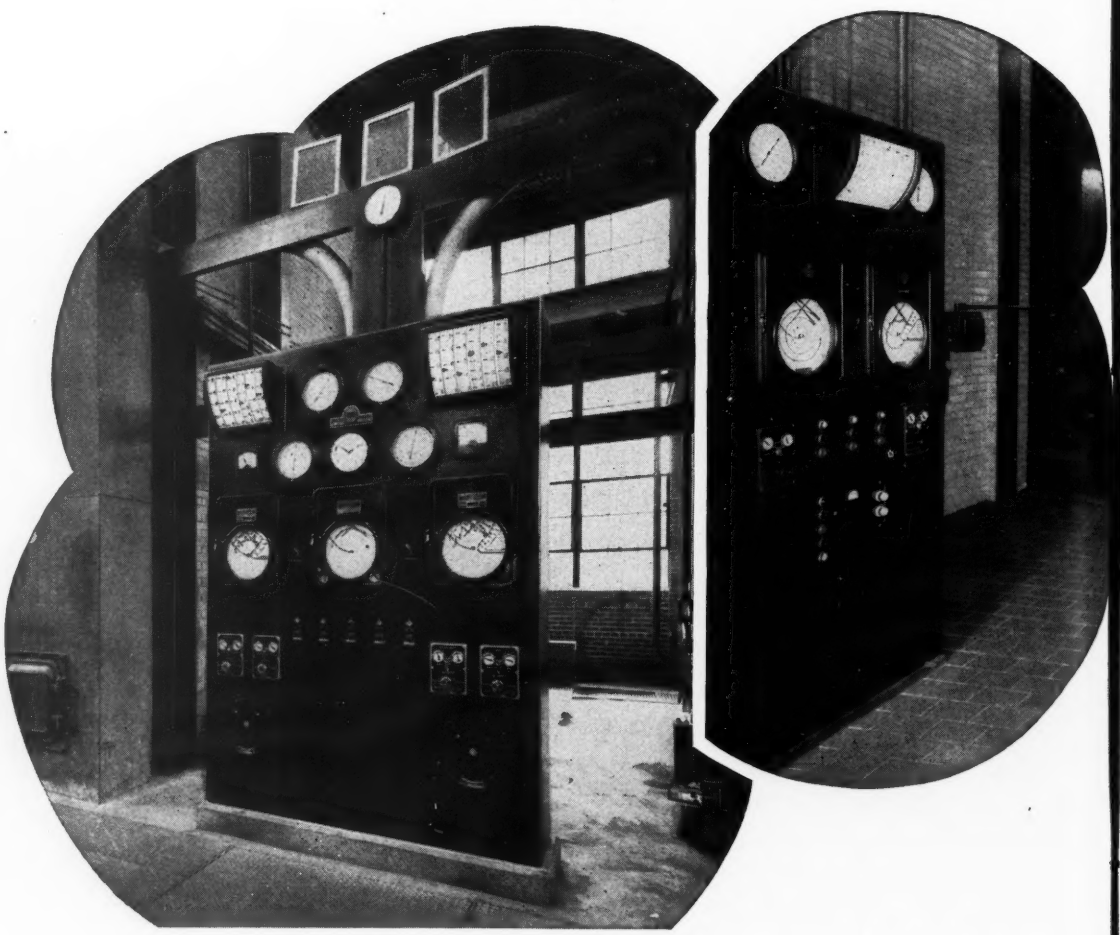

Left—Bailey Boiler Control Panel for two 60,000 lb. per hr. capacity pulverized coal fired boilers at Durez Plastics and Chemicals, Inc., North Tonawanda, N. Y.; Right—Bailey Control Panel for a 110,000 lb. per hr. capacity boiler, fired by a spreader type stoker at the Municipal Power Plant, City of Wyandotte, Mich.

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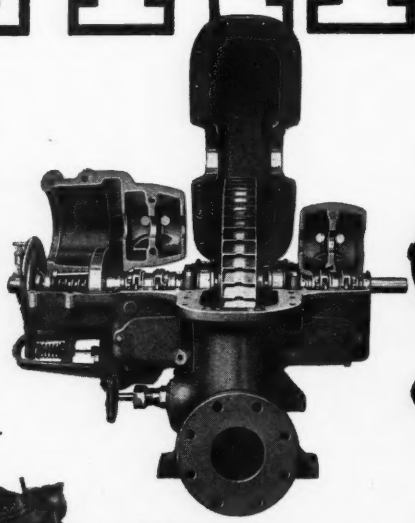
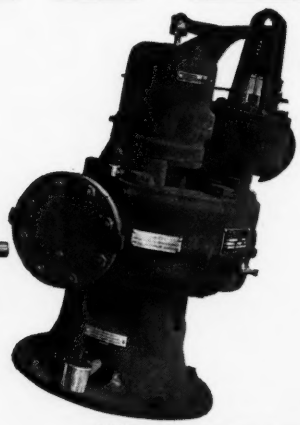
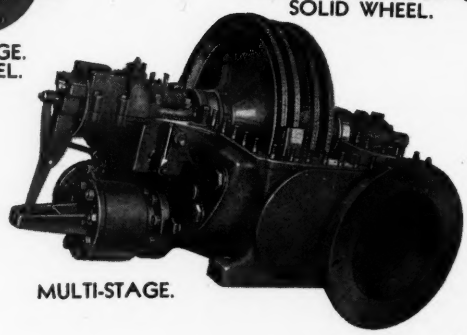


SINGLE STAGE.
SOLID WHEEL.



VERTICAL SINGLE STAGE
SOLID WHEEL.

MULTI-STAGE.
OIL RELAY GOVERNOR.



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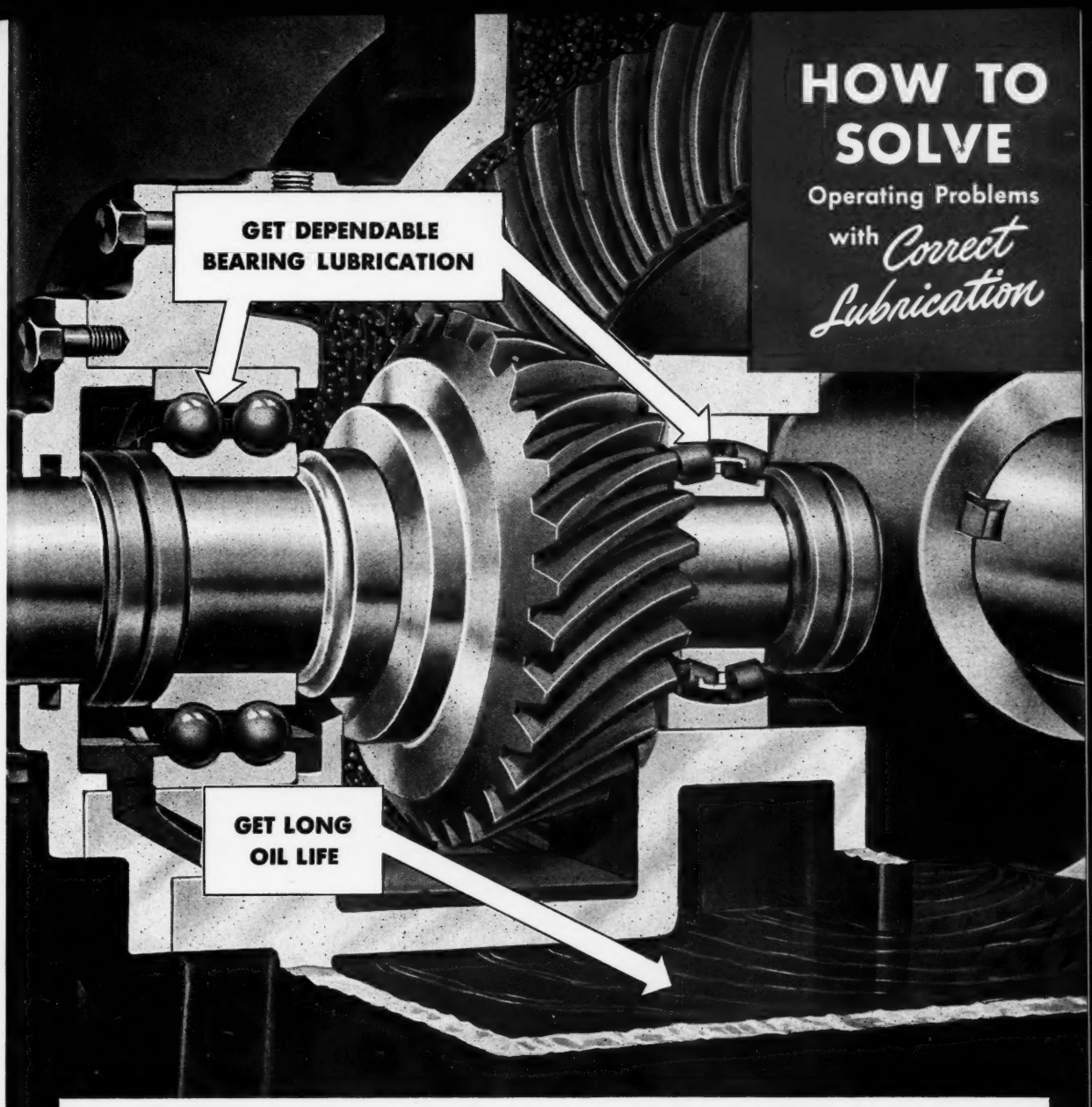
THE TERRY STEAM TURBINE COMPANY
TERRY SQUARE, HARTFORD, CONN.



HOW TO SOLVE

Operating Problems with *Correct Lubrication*

Reduce Wear_Get a *Plus*, too

OF COURSE YOU WANT gear tooth wear kept to a minimum! Gargoyle Vacuoline Oil will help you do that in a splash or circulation oiling system. It forms an oil film of high lubricity and great strength.

But can you get more, too? What about the LIFE OF THE OIL? Does the oil you use separate easily from water? Is it free from emulsions and sludge? WHAT ABOUT THE BEARINGS? Does the oil you use protect them from damaging rust?

Here's the point: Gargoyle Vacuoline Oil does not only minimize wear. *It also minimizes rusting danger* in the bearings. *And it lasts long.*

Yes, by all means, *insist* on an oil that reduces tooth wear—but get the "plus" of long bearing life, long oil life by using Gargoyle Vacuoline Oil.

GARGOYLE
Lubricants

SOCONY-VACUUM OIL COMPANY, INC. — Standard Oil of N. Y. Div. • White Star Div. • Lubrite Div. • Chicago Div. White Eagle Div. • Wadhams Div. • Magnolia Petroleum Company • General Petroleum Corporation of California

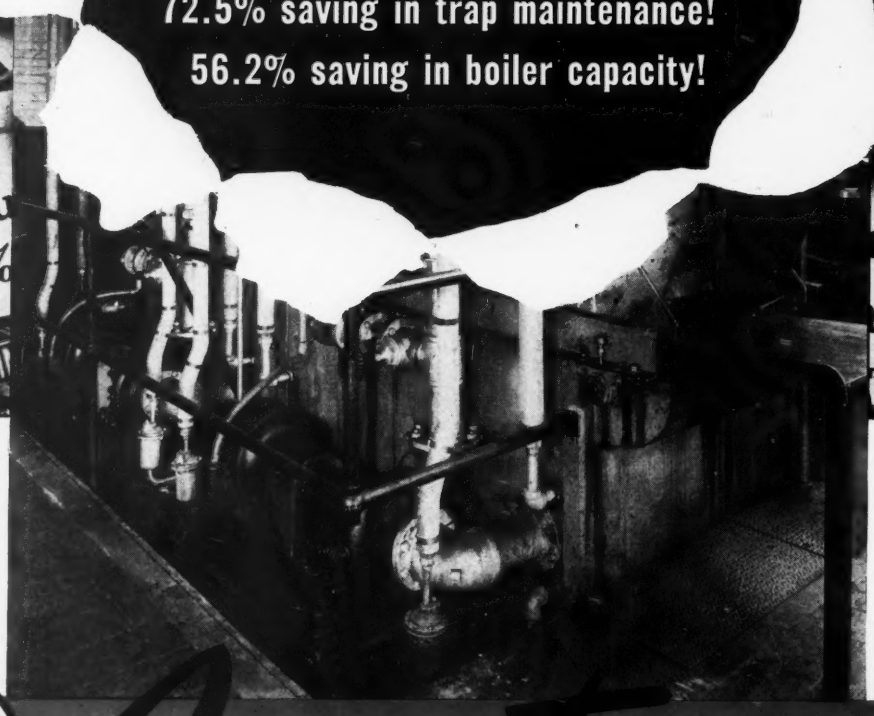
CALL IN SOCONY-VACUUM

Save 19 Days Maintenance Time Per Mont

SAVINGS

Of reports turned
in over the past 13 years
dealing with savings secured by
Armstrong trapping, those that give
figures show the following average or
typical percentages:

38.5% saving in fuel!
40.0% saving in heating time!
72.5% saving in trap maintenance!
56.2% saving in boiler capacity!



Right—Armstrong steam traps draining metal washing machine in large industrial plant, which has installed 674 Armstrong traps in the past 18 years.

ARMSTRONG · INVERTED BUCKET · STEAM TRAP

Armstrong

that helps WAR PRODUCTION

CONSIDERING the small amount of metal and the small cost involved in Armstrong steam traps the savings they offer in fuel, time, manpower, metal and money are impressive indeed.

Some typical examples: A pumping plant saved $2,600 a year in steam cost by installing Armstrong traps. A packing company cut cooking time on kettles 57%. A laundry spent only $3.00 for maintaining 32 Armstrong traps in 6 years. A canning plant found it possible to get along without a new boiler after changing over to Armstrong traps.

These benefits didn't just happen. They were built into Armstrong Traps in the form of big hot condensate capacity, automatic air handling ability, long life parts and trouble free design. No other trap offers the free floating valve, only two moving parts, self-scrubbing action, and complete freedom from sticking or binding. Write today for the Armstrong Trap Book giving facts and figures on traps for every job.

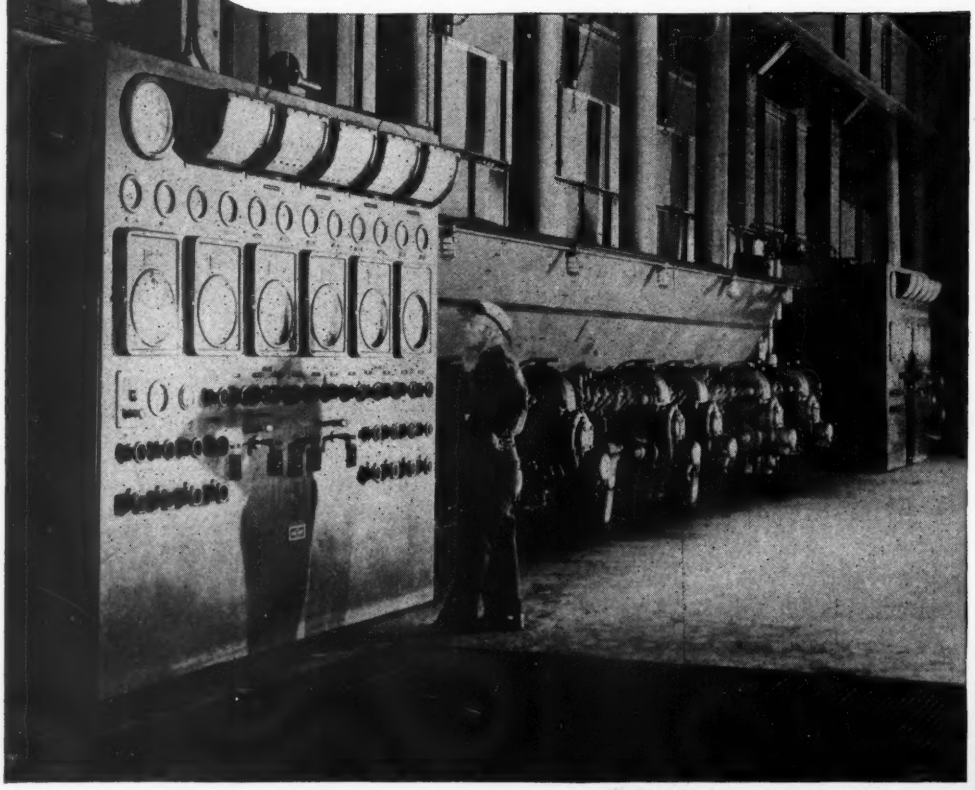
SILLY—ISN'T IT? But it's just as silly to have traps that don't remove both air and condensate, or that don't operate efficiently at all times.

ARMSTRONG MACHINE WORKS
810 Maple Street
Three Rivers, Michigan

Experienced sales and service engineers in all principal cities. Traps carried in stock at 144 points.

STEAM TRAPS

Rifle-sight accuracy



IN POWER PLANTS Hagan Automatic Combustion Control increases steam output, reduces fuel consumption, keeps steam pressure constant, eliminates smoke trouble, maintains efficient operation even with new men.

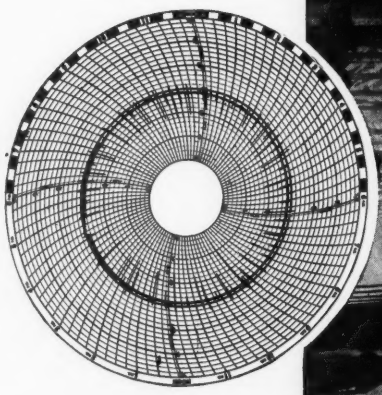
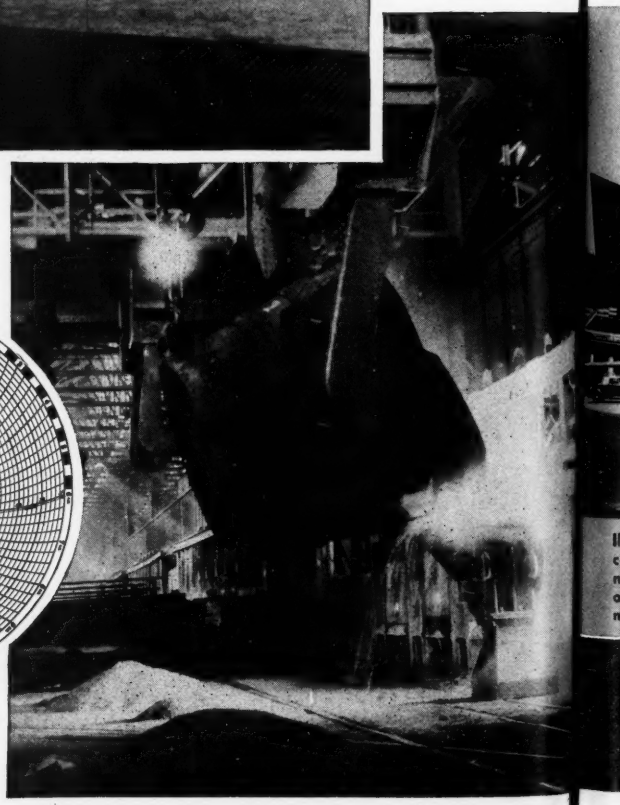


CHART SHOWS accuracy of pressure maintenance even under widely varying load conditions.



ON INDUSTRIAL FURNACES Hagan Control increases furnace output, cuts fuel consumption, results in faster, more uniform heating, steps up over all production, reduces spoilage.

y of Hagan Control . . .

helps conserve the nation's fuel supply

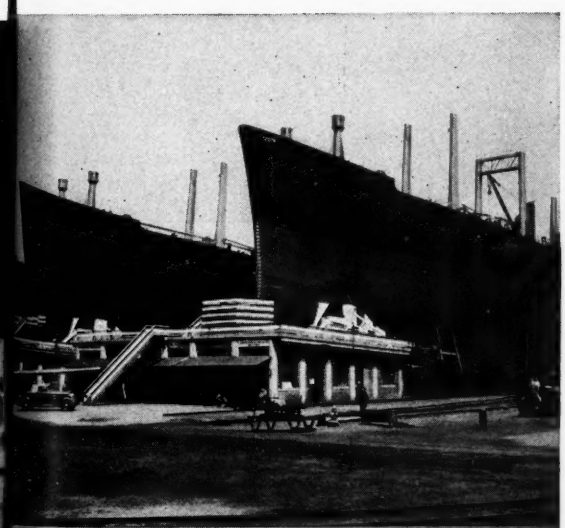
A TURBINE room engineer who was accustomed to seeing steam pressure *vary all over the lot* was having his first experience with Hagan Control. He discovered the pressure recorder was drawing almost a perfect circle. Not being used to such accuracy, he figured the gauge was stuck and proceeded to take it apart, only to find it in perfect working condition. About that time the Hagan Engineer happened along and put him wise to the fact that this was *usual* accuracy for Hagan Control.

Translate this accuracy into more efficient combustion and you will see how it has stretched the nation's fuel supplies. During the last war automatic combustion control was unknown until Hagan introduced it in 1917. We had fuel shortages so severe that expediters were riding coal trains to see that they reached the right destination.

Contrast this with the situation today. In spite of the fact that the United States is producing power almost double that used in the peak of 1929, we have had no permanent fuel shortages.

How much of this improvement is due to more efficient combustion is anybody's guess but of this we are certain—*almost every major boiler plant in the country is now equipped with automatic combustion control.* Furthermore, this fuel-saving apparatus is rapidly being installed on all types of industrial furnaces and steamships.

When Hagan Automatic Control goes in, fuel consumption drops. Sometimes it is only 1 or 2%, but more often it is 5 to 10%. This means that thousands of tons of fuel daily that formerly went up in smoke are now producing extra power to help win the war.



IN STEAMSHIPS Hagan Control increases cruising range or cargo-carrying capacity, eliminates the smoke hazard, maintains more constant superheat, steps up efficiency, obtains quicker response from boilers, carries on even if men are wounded.

HAGAN CONTROL ASSURES

MAXIMUM QUANTITY of steam from any given plant, by introducing fuel and air in correct proportion for utmost efficiency.

MAXIMUM UTILIZATION value, uniform steam pressure and temperature, in accordance with demand.

MAXIMUM OUTPUT from boilers of differing capacities, automatically.

MAXIMUM STEAM for production, by reducing loss of steam in frequent soot-blowing.

MAXIMUM PROTECTION of auxiliary equipment, fans, stokers, etc., by maintenance of uniform operating conditions.

HAGAN CORPORATION
HAGAN BUILDING
PITTSBURGH (30), PA.

HAGAN
HALL
BUROMIN
CALGON

HAGAN *Automatic* COMBUSTION CONTROL

The pioneer . . . and still the leader

ABRUPT LOAD CHANGES FROM 10,000 TO 80,000 POUNDS STEAM

•

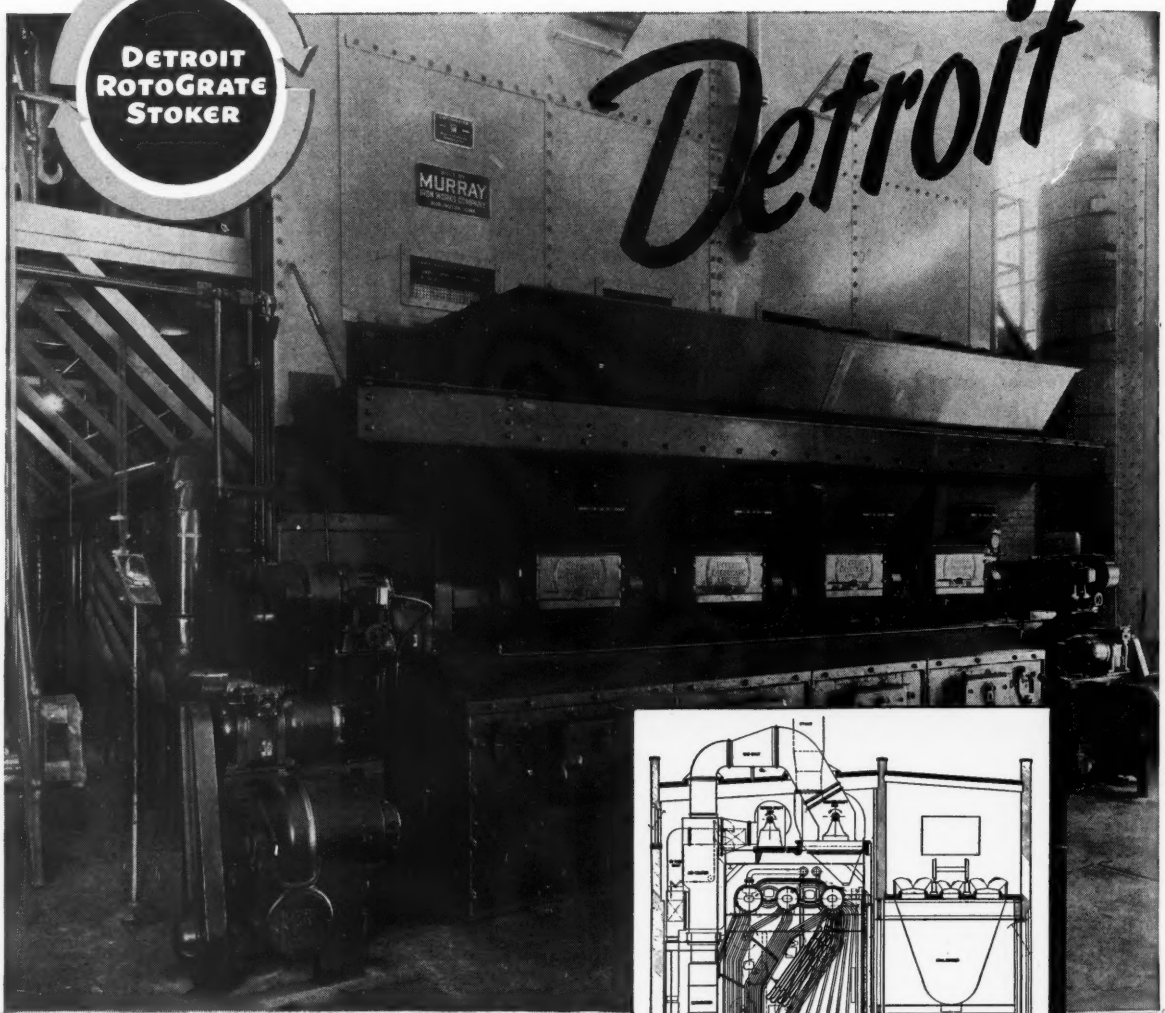
UNIFORM PRESSURE MAINTAINED

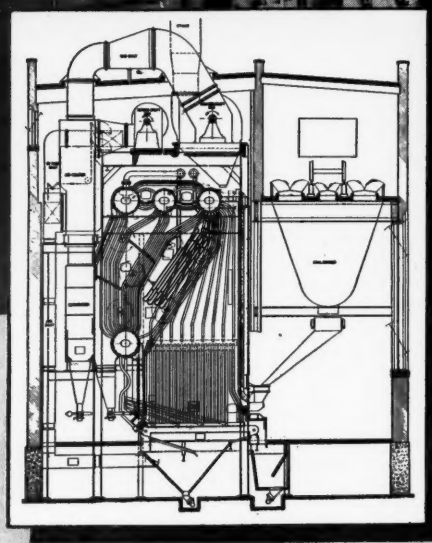
•

REPORT OVER 88% EFFICIENCY

DETROIT ROTOGRATE STOKER

Detroit





CONTINUOUS CLEANING GRATE MOVES FORWARD

Steam Generator and Detroit RotoGrate Stoker designed for:

75,000# hr. continuous capacity • 450# pressure • 500°F-present steam temperature • 750°F-future steam temperature • 250°F-air for combustion

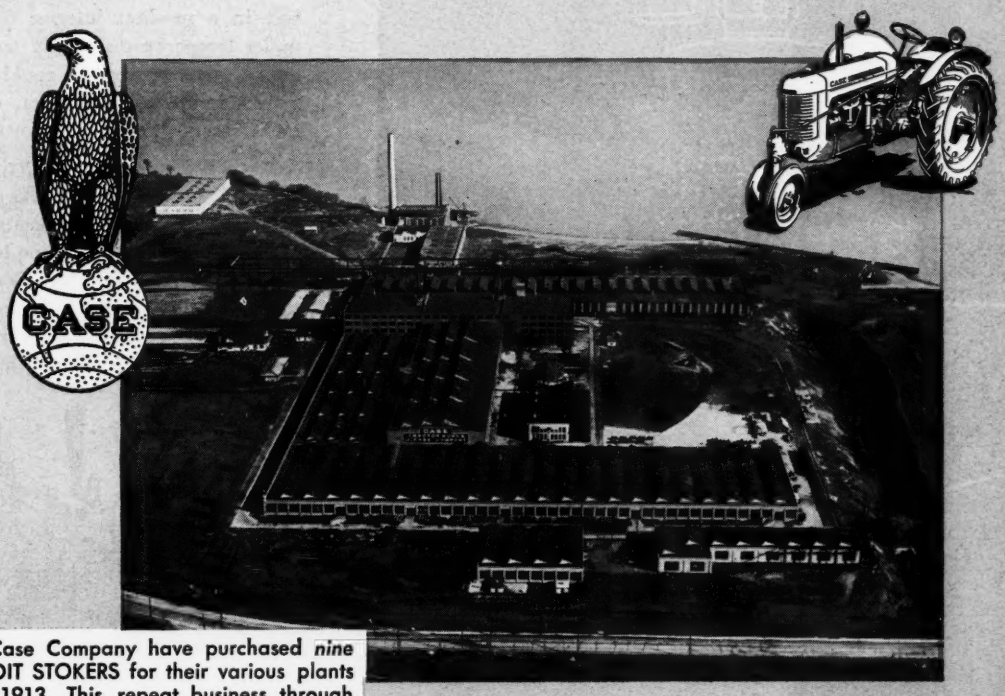
Heating Surfaces:

Boiler—7050 sq.ft. • Water walls—262 sq.ft. (projected area) • Superheater—693 sq.ft. (present area), 1655 sq.ft. (future area) • Economizer—3696 sq.ft. • Air heater—6540 sq.ft.

RotoGrate Stoker

At J. I. Case Company

Tractor Works—Racine, Wisconsin



J. I. Case Company have purchased *nine* DETROIT STOKERS for their various plants since 1913. This repeat business through the years is significant.

Investigate the recent development for greater Economy in the Production of steam. The RotoGrate combines all the advantages of *suspension burning* with a *forward moving grate.* Ashes are *continuously* discharged at the front of the boiler. No clinker troubles. Operation is smooth and uninterrupted and requires an extremely small amount of power.

Write now for Literature

DETROIT STOKER COMPANY

General Motors Building • Detroit 2, Michigan

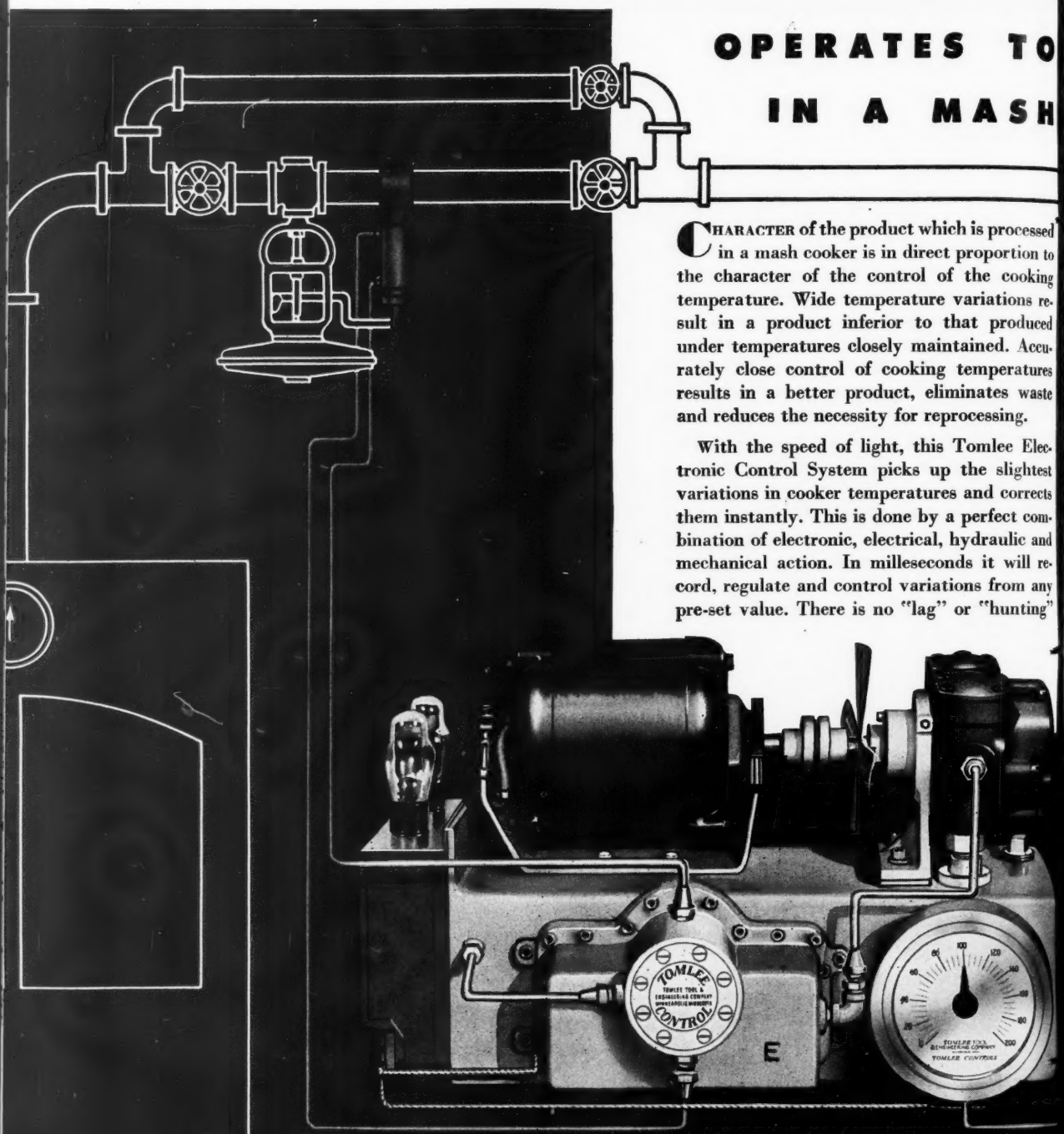
How the TOMLEE

OPERATES TO

IN A MASH

CHARACTER of the product which is processed in a mash cooker is in direct proportion to the character of the control of the cooking temperature. Wide temperature variations result in a product inferior to that produced under temperatures closely maintained. Accurately close control of cooking temperatures results in a better product, eliminates waste and reduces the necessity for reprocessing.

With the speed of light, this Tomlee Electronic Control System picks up the slightest variations in cooker temperatures and corrects them instantly. This is done by a perfect combination of electronic, electrical, hydraulic and mechanical action. In milleseconds it will record, regulate and control variations from any pre-set value. There is no "lag" or "hunting"



Electronic Control System

TO CONTROL THE TEMPERATURE

OF A MASH COOKER FOR ACCURATE PROCESSING

with their accumulation of repeated errors. Waste time and repeated processing of materials are completely eliminated by employment of the Tomlee Electronic Control Systems.

Wherever control and regulation of time, temperature, pressure, quantity or flow is required, Tomlee Electronic Control Systems furnish the ultimate in accurate control.

The Tomlee Electronic Control is the product of a young, aggressive organization, highly skilled in the production of precision apparatus. Our engineers are in a position to apply the Tomlee principle of electronic control to practically any control problem. Write for complete information. TOMLEE TOOL AND ENGINEERING COMPANY, 253 Third Avenue, South, Minneapolis 15, Minnesota.

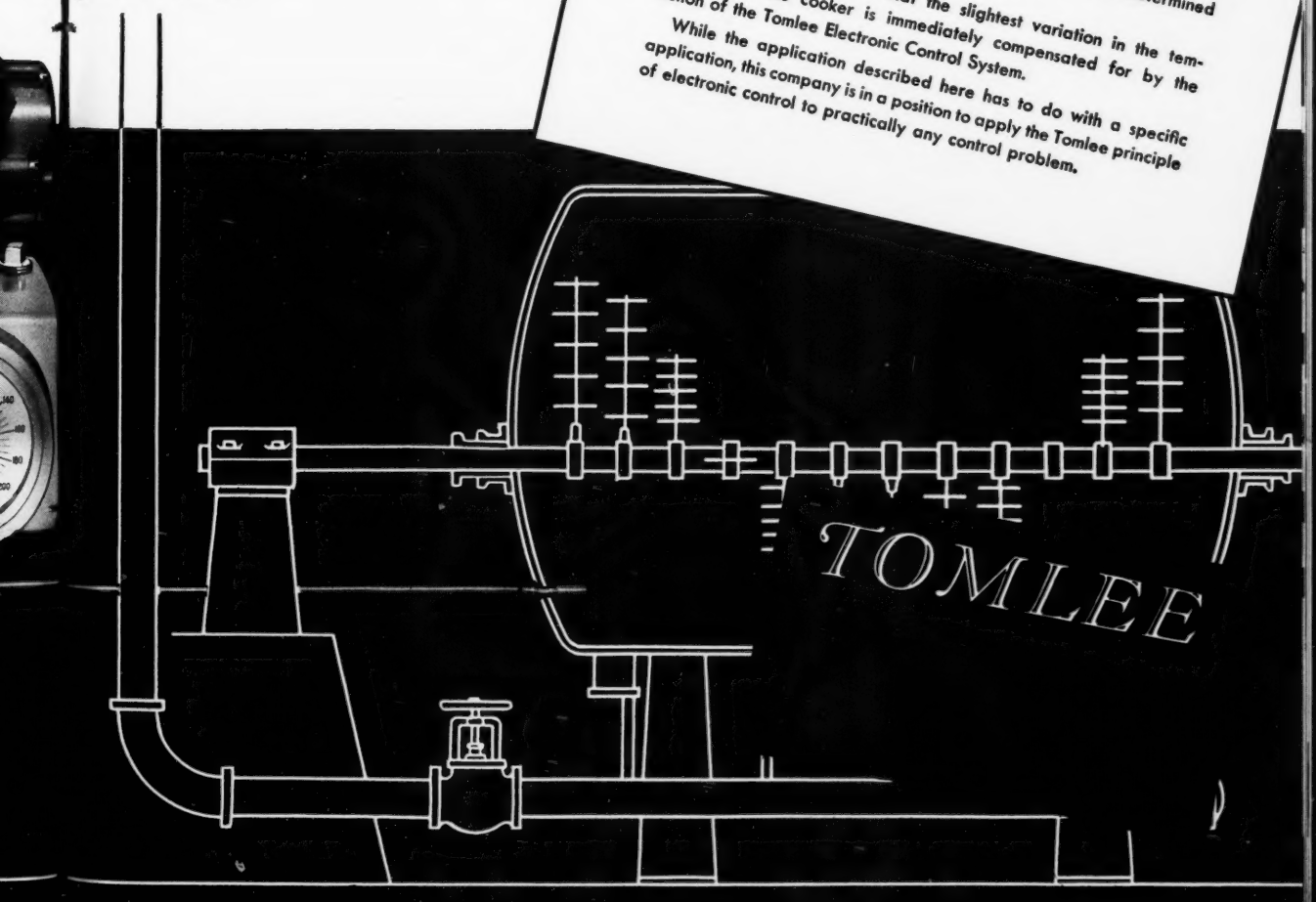
HOW THIS MASH COOKER OPERATES WITH TOMLEE ELECTRONIC CONTROL

As very slight changes in temperature occur at thermometer (A) they are transmitted through impulse tube (B) to diagnosing unit (C) which has been pre-set at the exact temperature which it is desired to have maintained in the mash cooker.

All variations even of the slightest degree from the pre-set value in diagnosing unit (C) are transmitted to tubes (D). A feeble current of only 2 milliamperes is amplified in the electronic unit to standard 110 volts and operates either of two electro-magnets, which in turn control the action of 4-way valve (E). This valve sends hydraulic pressure to either side of hydraulic piston (G) causing valve (H) to proportion the volume of steam in line (J) in the amount necessary to hold temperature in the mash cooker to the pre-determined value set in diagnosing unit (C).

It can be readily seen that the slightest variation in the temperature in the cooker is immediately compensated for by the action of the Tomlee Electronic Control System.

While the application described here has to do with a specific application, this company is in a position to apply the Tomlee principle of electronic control to practically any control problem.



SHELL INDUSTRIALL
HELPED TO WRITE
OF

A REVIEW OF ACCOMPLISHMENTS

Behind those history-making headlines made on the battlefront during the past year are the men, tools, machines and materials that have built ships in a matter of days instead of months . . . produced guns, planes, and tanks in undreamed-of quantities. In there, pitching for a speedy Axis strike-out, are Shell Industrial Lubricants—a few of which are high-spotted here.

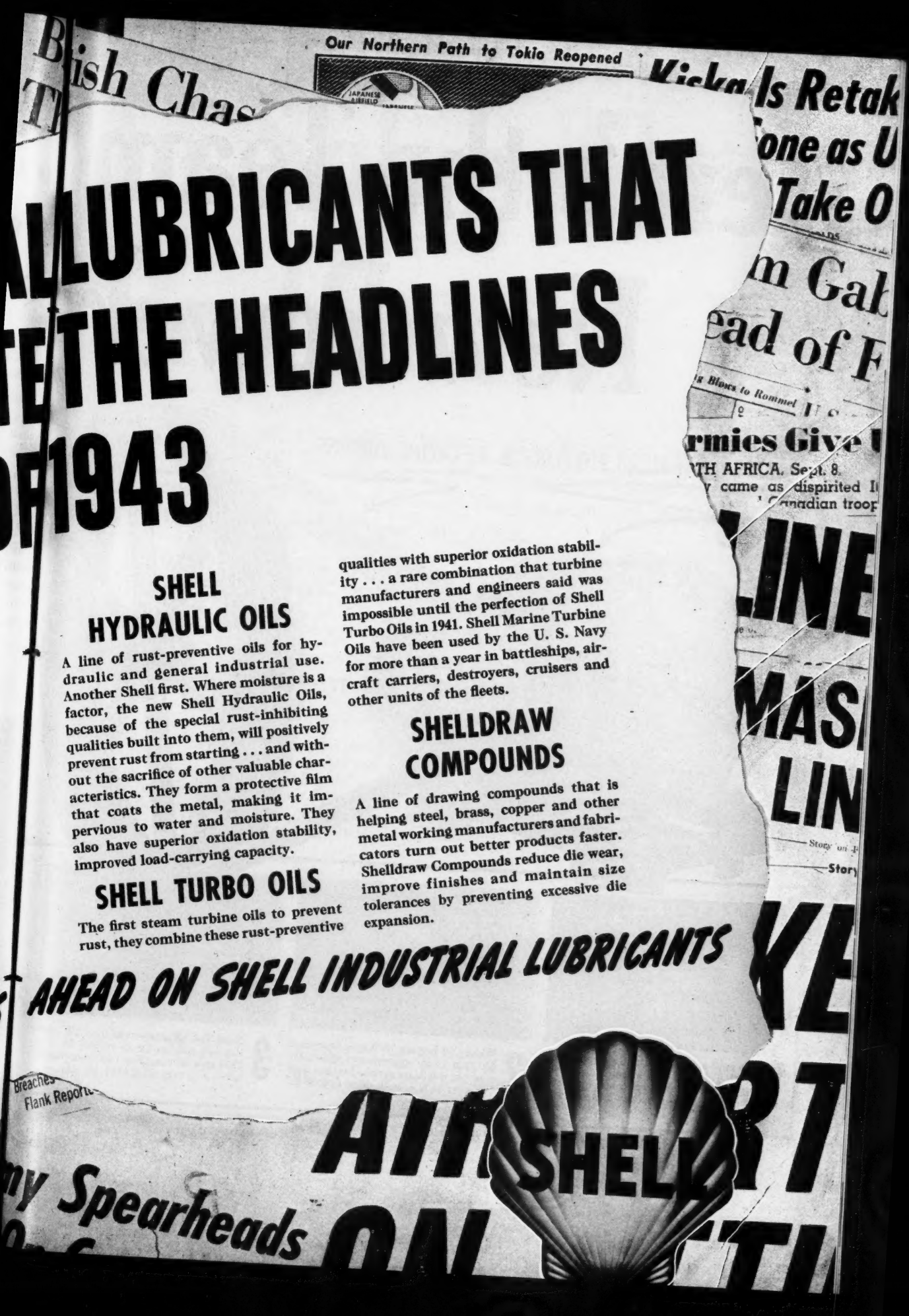
SHELL VIRGO OILS

This line of soluble metal working oils combines high cooling efficiency with good rust protection. Shell Virgo Oils can be removed with water, leaving the metal surface clean enough to paint. Their high wetting characteristics make them extremely economical to use.

SHELL CUTTING OILS

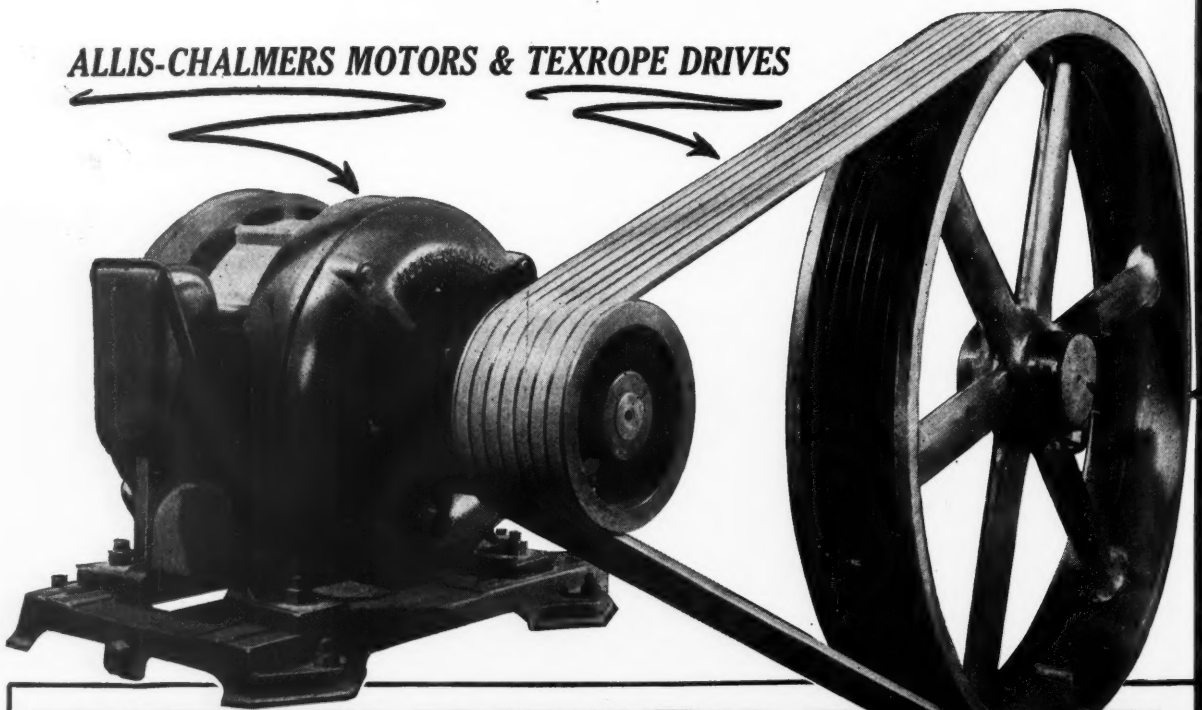
A complete line of sulphurized cutting oils and coolants, both transparent and dark, that have been largely responsible for finer finished products, less down-time, longer tool life, with increases in war production that astonished even veteran machine-tool manufacturers.

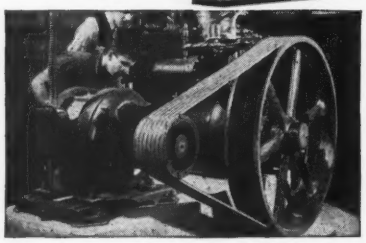
AMERICA'S WAR PRODUCTION SPEEDS


Our Northern Path to Tokio Reopened
JAPANESE AIRFIELD
ALLUBRICANTS THAT
TE THE HEADLINES
OF 1943
SHELL
HYDRAULIC OILS
A line of rust-preventive oils for hydraulic and general industrial use. Another Shell first. Where moisture is a factor, the new Shell Hydraulic Oils, because of the special rust-inhibiting qualities built into them, will positively prevent rust from starting . . . and without the sacrifice of other valuable characteristics. They form a protective film that coats the metal, making it impervious to water and moisture. They also have superior oxidation stability, improved load-carrying capacity.
SHELL TURBO OILS
The first steam turbine oils to prevent rust, they combine these rust-preventive qualities with superior oxidation stability . . . a rare combination that turbine manufacturers and engineers said was impossible until the perfection of Shell Turbo Oils in 1941. Shell Marine Turbine Oils have been used by the U. S. Navy for more than a year in battleships, aircraft carriers, destroyers, cruisers and other units of the fleets.
SHELLDRAW
COMPOUNDS
A line of drawing compounds that is helping steel, brass, copper and other metal working manufacturers and fabricators turn out better products faster. Shelldraw Compounds reduce die wear, improve finishes and maintain size tolerances by preventing excessive die expansion.
AHEAD ON SHELL INDUSTRIAL LUBRICANTS
SHELL

Here's the Team New Power

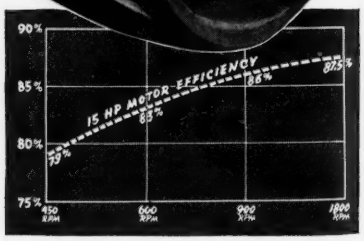
ALLIS-CHALMERS MOTORS & TEXROPE DRIVES





1 In most applications, an 1800 rpm motor with Texrope Drive will ably do the job of a lower-speed, direct-connected motor —at lower cost in money *and materials!*

2 When you buy an 1800 rpm instead of 450 rpm 15 hp squirrel-cage motor, for example, 600 lb are saved. And *you* save well over $200 — with drive figured in!



3 Note that efficiency rises from 79% for the 450 rpm motor to 87.5% for the 1800 rpm motor. The 1800 rpm motor saves you over 30 kw/24 hr. day.

ALLIS-C

to Solve These Problems!

1. HOW TO DRIVE LOW SPEED MACHINERY WITH HIGH SPEED MOTORS? Allis-Chalmers Texrope Drives can "gear down" motor speeds over a range of 7 to 1. They're compact, highly efficient, protect your equipment by absorbing shock.

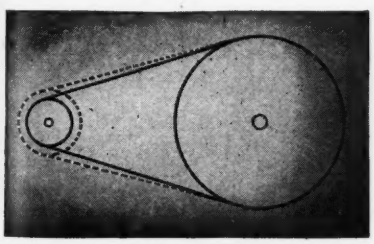
2. HOW TO DRIVE A MACHINE AT DIFFERENT RATES WITH A SINGLE SPEED MOTOR? Texrope Adjustable-Speed Drives give you infinite speed range up to 375%. And in Allis-Chalmers' full line of Texrope Drive equipment you'll find the *right* range for your machines . . . thus avoid paying extra for more speed than you need.

NOW THAT low-speed and multi-speed motors are sharply restricted, get the *flexibility* you need by teaming up available types of Allis-Chalmers Lo-Maintenance Motors with Texrope Drives.

As America's only builder of *both* motors and V-belt drives, Allis-Chalmers has long studied and advocated their use in proper combination. Today, you benefit from Allis-Chalmers pioneering when you ask for—and get—the *right* combination of Lo-Maintenance Motor and Texrope Drive.

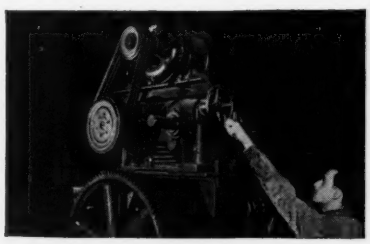
Call on any A-C district office or write to ALLIS-CHALMERS MFG. CO., MILWAUKEE 1, WIS.

A1647



4 Infrequently needed speed changes can be had by changing from one size motor sheave to another. Juggling *complete* drives, range is 1:1 to 7:1.

5 With the Allis-Chalmers Vari-Pitch Sheave, you can increase or decrease speed by adjusting sheave diameter . . . obtaining an *unbroken* series of speeds!



6 Allis-Chalmers Vari-Pitch Speed Changer gives you infinite changes at the turn of a wheel — within 3.75 to 1. It's compact, flexible, *efficient!*

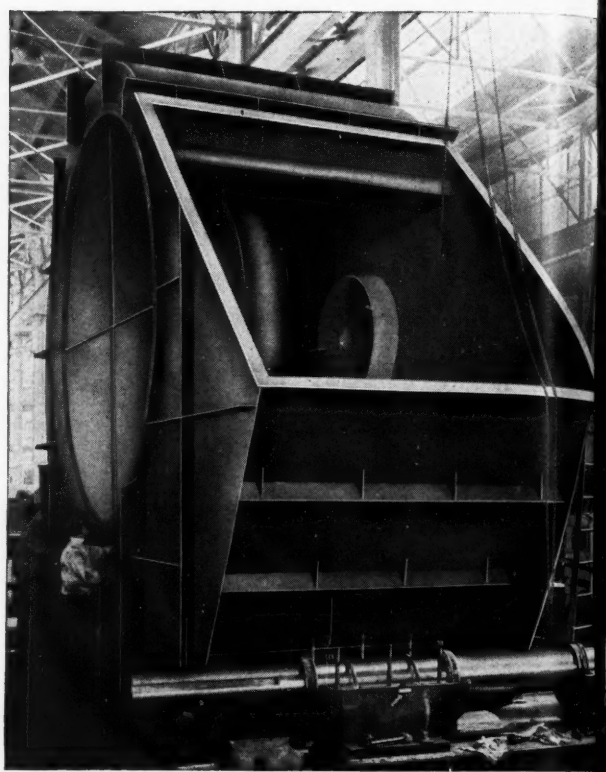
-CHALMERS *LO-MAINTENANCE MOTORS TEXROPE DRIVES*

Progress and Power in the

America's automotive industry has won world-wide fame for efficiency and mass production methods. Passenger car production for the United States and Canada reached its peak in 1941 (last pre-war year of unlimited production) when 3,838,345 passenger cars and 1,270,647 trucks rolled off the lines. Yet the war production of this great industry makes even these totals look small.

For many years, American Blower dust collectors, fans for air circulating and ventilating and for exhausting fumes from paint spray booths, foundries, etc., have been a stand-by in the automotive industry. American Blower Mechanical Draft Equipment and Fluid Drives have been used also in many of the leading public utilities which furnish the automotive industry with electrical energy.

After Victory, the experience gained by American Blower in furnishing vital air handling equipment to all industries will be available to you for your plant or process.

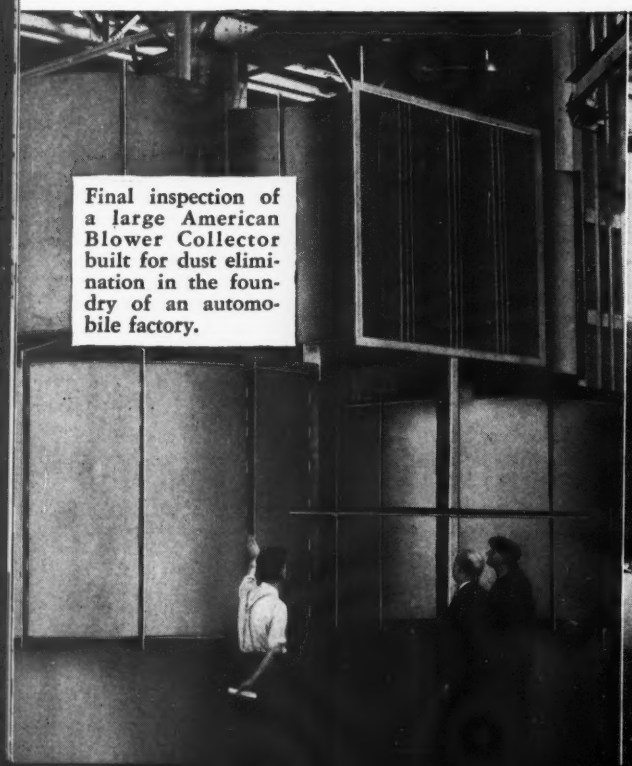


Large American Blower Supply Fan used as a part of a central system for air circulation and ventilation in an automotive assembly plant.

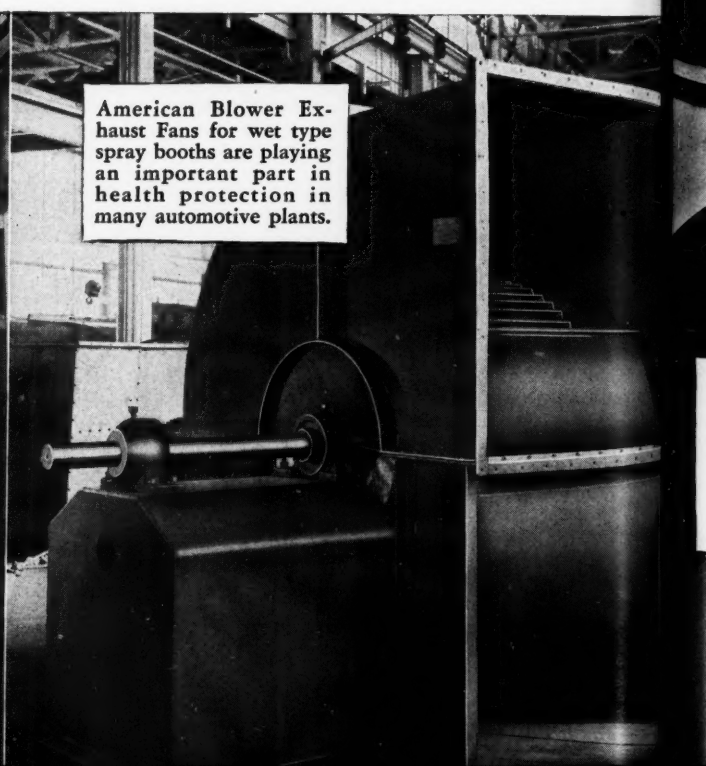
AMERICAN BLOWER

ARMY-E-NAVY
For Production "Well Done"

AMERICAN BLOWER CORPORATION, DETROIT, MICH.
CANADIAN SIROCCO COMPANY, LTD., WINDSOR, ONT.
Division of American Radiator and Standard Sanitary Corporation

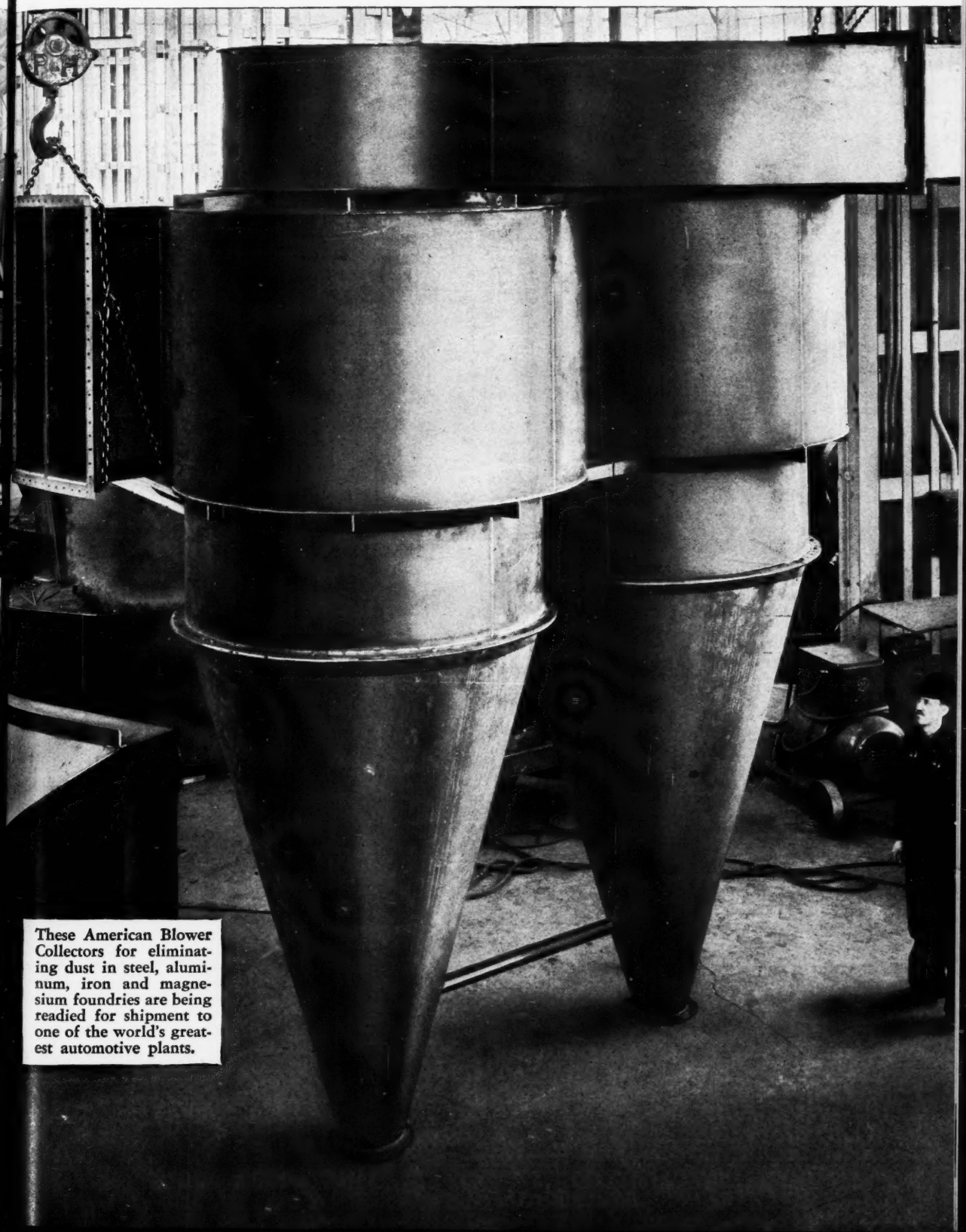


Final inspection of a large American Blower Collector built for dust elimination in the foundry of an automobile factory.



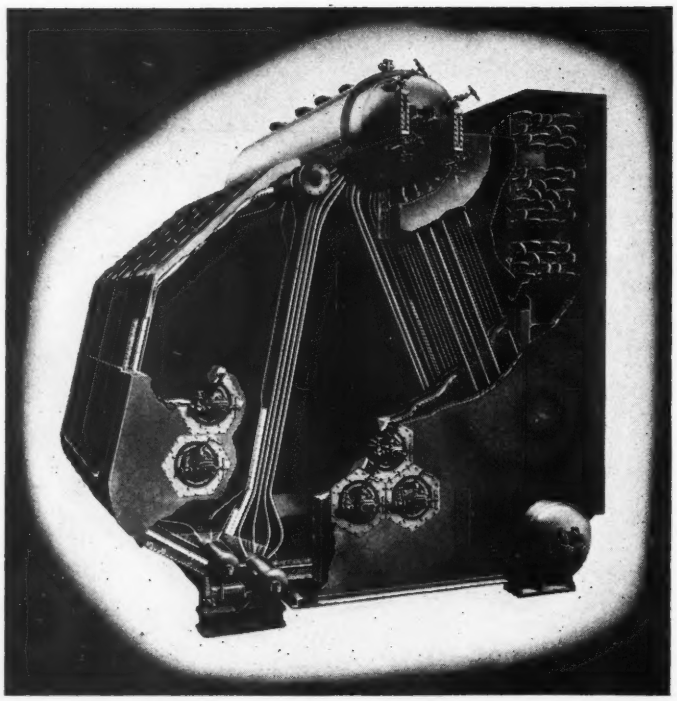
American Blower Exhaust Fans for wet type spray booths are playing an important part in health protection in many automotive plants.

AUTOMOTIVE INDUSTRY



These American Blower Collectors for eliminating dust in steel, aluminum, iron and magnesium foundries are being readied for shipment to one of the world's greatest automotive plants.

BLAZING the



MARINE SEPARATELY-FIRED SUPERHEATER STEAM GENERATOR

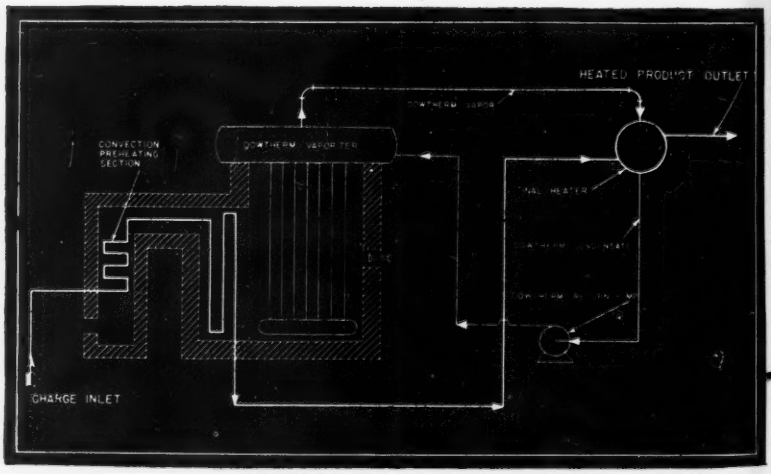
● This steaming unit offers advantages unobtainable with usual standard constructions:

1. Precision control of final steam temperature independent of rate of steam generation.
2. Saturated steam can be taken directly from steam drum without any desuperheaters.
3. Any combination and quantity of superheated and saturated steam as required to temperatures of 850° F.
4. All superheater surfaces exposed to furnace, hence easy to clean.
5. High overall efficiency, light in weight, flexible in service, low in maintenance, prodigious in power.

OIL HEATING WITH DOWTHERM

PROBLEM: Heating a sensitive oil to 650 Deg. F. Danger of overheating makes use of direct firing impractical.

SOLUTION: Oil is first preheated to 550 Deg. F. in convection and semi-radiant sections of a combination direct-fired oil heater and Dowtherm Vaporizer. In the final stage the oil is heated from 550 Deg. F. to 650 Deg. F. in a shell and tube type preheater by condensing Dowtherm Vapor generated by radiant tubes in the furnace of the direct-fired heater. The system eliminates the danger of localized overheating and effects the close temperature control on which the success of the process depends.

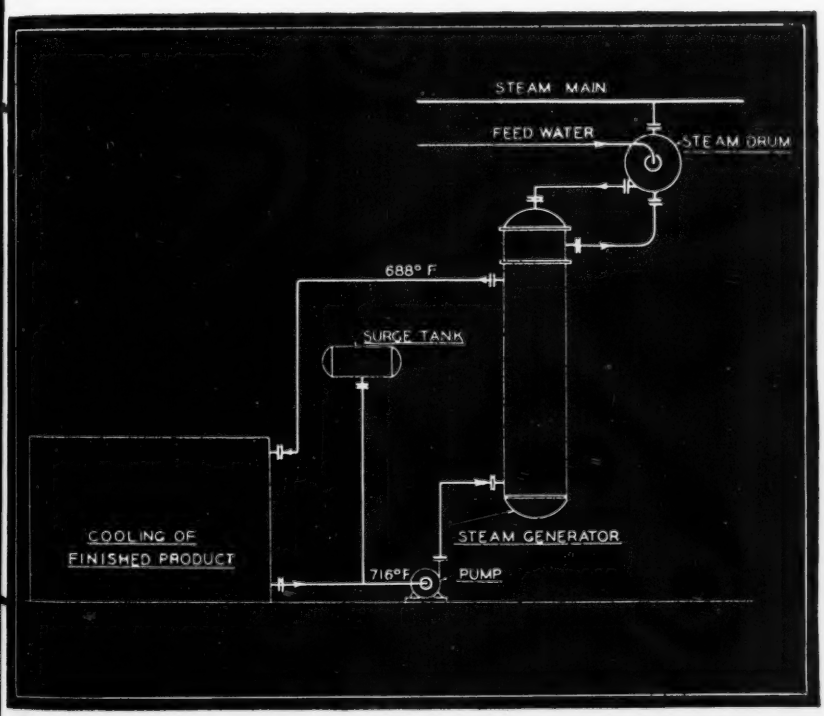


FW FOSTER

ENGINEERING TRAIL

The contribution of progressive engineering is its ability to successfully solve difficult and unusual problems. Foster Wheeler concentrates on original engineering research, both as to improving existing designs and exploring the possibilities of new developments. Three recent and prominent examples of such progressive engineering are: The separately-fired superheater marine steam generator; the industrial application of Dowtherm for the conversion of waste heat into power and for the heating of sensitive oils.

FOSTER WHEELER CORPORATION, 165 BROADWAY, NEW YORK 6, N. Y.

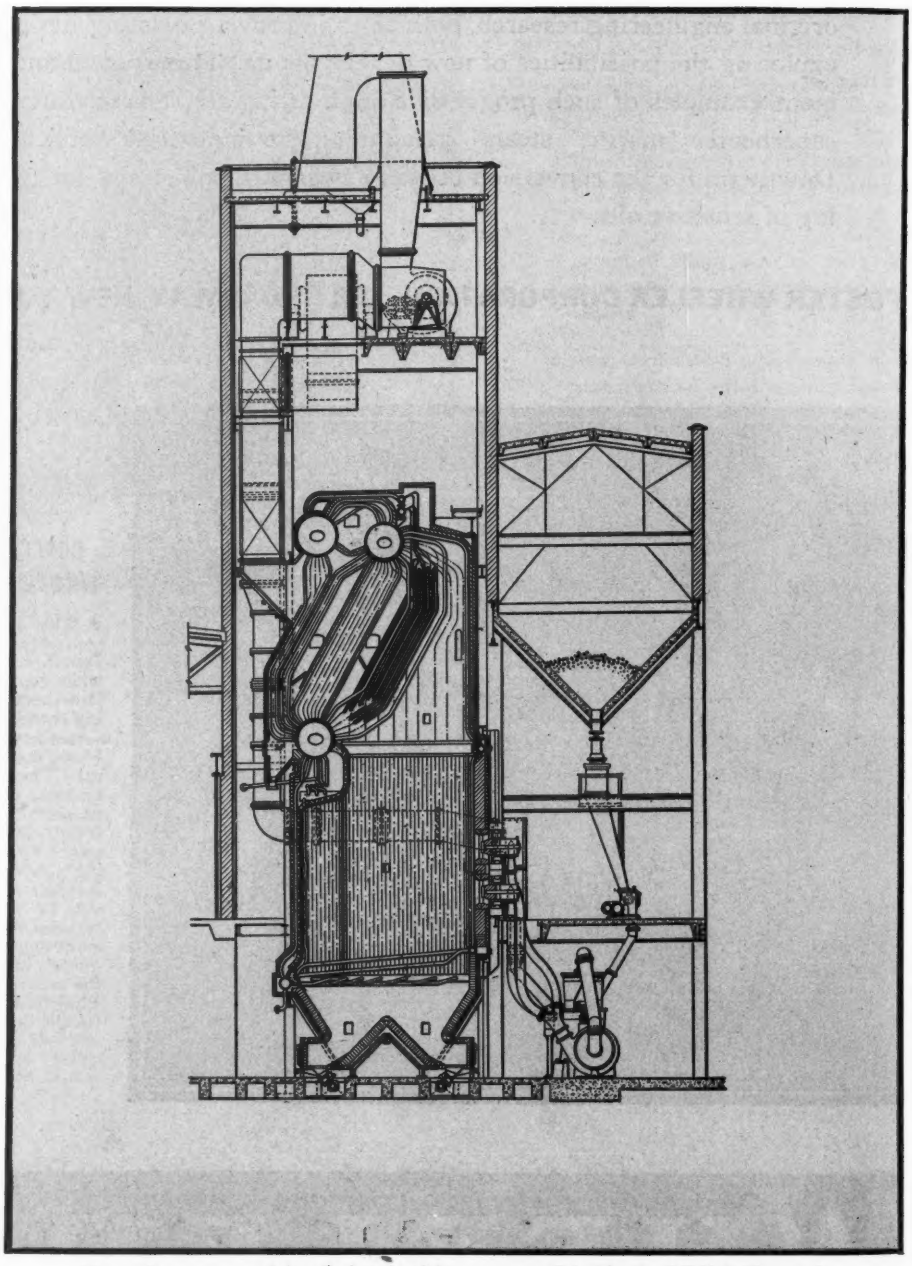


DOWTHERM CONVERTS WASTE HEAT TO POWER

● This system utilizes the high temperature characteristics of Dowtherm to cool the product while generating steam for power. Dowtherm liquid leaves the cooling chamber at 716 Deg. F., enters a steam generator and produces 14,400 lb. of steam per hour at 600 psi. This heat recovery system operates at less than 150 lb. gage pressure (the boiling point of Dowtherm at 135 lb. gage pressure is 750 Deg. F.) thus eliminating need of a costly high pressure installation or use of a less suitable or more expensive heating transfer medium. If a more constant temperature control is required in the chamber utilizing the recovered heat, Dowtherm in vapor form would be substituted for the liquid.

WHEELER FW

FULL YEAR OF CONTINUOUS



The performance record described at the right was accomplished by the C-E Unit illustrated above. It is one of two duplicate units installed in 1937. Maximum continuous capacity — 125,000 lbs. of steam per hr. Design pressure — 900 psi. Total steam temperature — 750 F.

WARTIME STEAM GENERATION

Money-saving C-E installation handles widely fluctuating loads without interruption

Here's another demonstration of the contribution being made by C-E steam generating equipment to the success of the war. It's a record from the plant of one of the most prominent names in radio where a huge volume of production is entirely directed toward war purposes.

The steam plant installation consists of two C-E Units which were first placed in service nearly six years ago. Besides a highly satisfactory performance in meeting steam demands, the C-E installation is credited with savings of more than $125,000.00 per year as compared with the equipment which it replaced.

But the past year of wartime service emphasizes the importance of the extra performance obtainable from steam generating equipment designed and built to the highest standards. For example, one of the C-E Units has just completed a full year of continuous service during which it was "on the line" 24 hours a day, seven days a week. Even then it was removed from service only for a scheduled inspection and cleaning. During the year, it handled steam output fluctuating between light, summer Sunday loads of 5,000 lb of steam to maximum peaks of 150,000 lb of steam, though the unit is designed for a maximum capacity of 125,000 lb of steam per hour. The average weekday load was substantial, approximately 90,000 lb per hour.

This performance parallels that of many war-time industrial and utility installations of C-E Steam Generating Units and is a reflection of the high standards which influence their original design and construction.

COMBUSTION ENGINEERING

200 MADISON AVENUE, NEW YORK 16, N. Y.

A-756

Canadian Associates: COMBUSTION ENGINEERING CORPORATION LIMITED • Montreal • Toronto • Winnipeg • Vancouver

More Air to make More Iron to make More Arms

Turbine Driven Blast Furnace Blower on test in De Laval Shops

Three De Laval BLAST FURNACE BLOWERS of the latest design are being built at the De Laval Works; two of which are for a steel company already operating four De Laval blowers having an aggregate inlet capacity of 262,000 cu. ft. per minute against 30 lb. gage maximum pressure.

Each of the new machines is rated at 90,000 cfm. of air, as measured at standard conditions of 60° F. and 30 in. barometer, and to deliver against 30 lb. per sq. in. maximum pressure, with an actual capacity of 97,800 cfm. at normal operating inlet pressure and temperature conditions.

The units are controlled automatically to deliver a constant weight of air.

The design and materials for the driving turbines are suitable for operation with a maximum steam pressure of 700 psig and maximum temperature of 775° F.

3825

De Laval STEAM TURBINE CO.
TRENTON 2, N.J.

MANUFACTURERS OF TURBINES... STEAM, HYDRAULIC; PUMPS... CENTRIFUGAL, CLOGLESS, ROTARY DISPLACEMENT, MOTOR-MOUNTED, MIXED-FLOW, PROPELLER; PRIMING SYSTEMS; CENTRIFUGAL BLOWERS and COMPRESSORS; GEARS... WORM, HELICAL; and FLEXIBLE COUPLINGS

Ferric oxide (Fe_2O_3), shown on steel test strip at top, is common red rust which is relatively non-abrasive. Metal failures from pitting occur only after many years.

Magnetic iron oxide (Fe_3O_4), below, forms hard black crystals which are highly abrasive, and severely score bearings—can cause a shut-down in short order.

A corrosion inhibitor in Nonpareil Turbine Oil guards against both types.

Turbine Corrosion

Its occurrence, cause, and correction

AS TURBINE EFFICIENCY was improved by higher speeds, temperatures, and steam pressures, oils that had been satisfactory for older turbine designs began to form sludge and other deposits. To eliminate these deposits more highly refined oils were introduced. But the higher degree of refining which removed deposit-forming elements also removed corrosion inhibitors from the oil, and resulted in a new and serious type of corrosion.

Two types of corrosion. Common rust (Fe_2O_3) is the most familiar type. It occurs on iron parts such as storage tanks, reservoirs, and oil lines where there is moisture above the oil level, or where water accumulates in pockets and depressions. This type does little damage unless allowed to continue over a period of years. Parts subject to such damage are sometimes treated with special protective coatings.

The most serious type of corrosion which has developed in recent years is caused by water carried in suspension in the oil. Even a small percentage of moisture—as low as 0.1%—will cause this corrosion. It forms dense, hard crystals of magnetic iron oxide (Fe_3O_4) which is highly abrasive and severely scores bearings—can clog oil lines and governor mechanisms in short order.

Corrosion problem analyzed. Nonpareil Turbine Oil has contained a corrosion inhibitor since 1926. But corrosion prevention has been under continuous study in our laboratories. Hundreds of tests have been made to find improved additives which would give increased protection against corrosion. Many products were excellent as rust preventives, but because of high acidity, poor demulsibility, poor color, etc., could not be incorporated without impairing the other desirable qualities of Nonpareil. From these tests emerged one thoroughly satisfactory rust preventive.

Passes A.S.T.M. test with perfect strip. Recently the American Society for Testing Materials developed Test D665-42T for determining the ability of Turbine Oil to aid in preventing the rusting of ferrous parts in the presence of water. Nonpareil Turbine Oil passes this test with a perfect test strip, and gives long time protection.

Get all the facts. You'll want to learn more about this interesting development. Send for a Standard Lubrication Engineer. He'll be glad to supply full test data and service records. Call any Standard Oil Company (Indiana) office, or write 910 S. Michigan Ave., Chicago 5, Illinois. In Nebraska, address Standard Oil Company of Nebraska at Omaha 2.

Oil is ammunition . . . Use it wisely

★ ★

NONPAREIL TURBINE OIL

★ ★

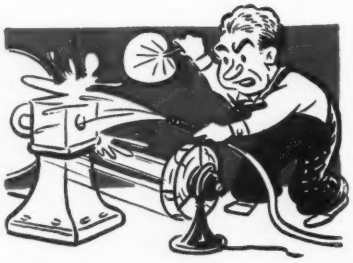
STANDARD OIL COMPANY (INDIANA) STANDARD SERVICE

★ LUBRICATION ENGINEERING

Lubrication *News* letter

Practical suggestions from the field on how Lubrication Engineering and lubricants are being used by midwest operators to lick tough wartime jobs.

DECEMBER, 1943



Eliminates need for cooling lines to mill bearings. Open cellar, grease lubricated bearings on a large ball mill at a Missouri paint company ran dangerously hot. The first remedy tried was expensive. Air and water lines, run to the bearings, helped reduce temperature somewhat. The second attempt was simple. A Standard Lubrication Engineer was called in. He suggested a test of Stanolind Mill Grease. In the first 10-hour test, bearings ran cooler. After two days, it was evident that the cooling lines would not be needed. Bearing temperatures dropped 45° F. to 115° F., and stayed there, with Stanolind Mill Grease as a lubricant and no special cooling.

Avoids shutdown of bar rolling mill. Worn splines on the shaft of a rolling mill caused waves in the bar material being rolled. A shutdown for repairs seemed unavoidable, as the condition of the splines would undoubtedly become worse. But a Standard Lubrication Engineer was a regular caller at this Detroit plant. Someone remembered to mention the problem to him. He suggested trying a comparatively new product—Calumet Viscous Lubricant. It might stave off a shutdown for repairs. The cushioning effect of the lubricant took up the slack in the worn splines. Further wear has been stopped, and the mill is turning out satisfactory work, with every indication that it will operate until replacements can be made.

"Hydrant squirts dog" or how Engineer overcomes oil vapor. War restrictions made it necessary to seal doors and windows of a Missouri power plant. The lack of ventilation made the vapor from engine oil almost suffocating to men in the plant. But the plant engineer's chief worry, when he called a Standard Lubrication Engineer, was that this vapor would damage insulation on motors and generators. After analyzing the problem, the oil man recommended Stanoil, instead of the red engine oil formerly used. Stanoil not only solved the bad vapor problem, but also gave so much better yield in reclaiming that the plant engineer wishes he had changed years ago.

Beats hot bearing problem in heat-treating oven. Many homemade remedies have been concocted from time to time by plant men in attempting to lubricate hot bearings in heat-treating and drying ovens. Most of these are made at considerable cost in time, in getting special ingredients, or in mixing and applying them. A Detroit manufacturer took an easier way. He called in one of our Lubrication Engineers, who made a very complete analysis, but a simple recommendation—Stanoil 200. Stanoil, right out of the barrel, ended the problem of coked lubricant in bearings and glazed shafts on a surface combustion, heat-treating oven. Stanoil may not solve your "hot bearing" problem, but a Standard Lubrication Engineer will.

What are YOUR problems in maintenance and lubrication?

The few examples cited here are typical of jobs Standard Lubrication Engineers are doing daily for operators who have asked for help. Take the time to explain your problems to one of these Engineers. He may have a number of suggestions that will help you save much needed manpower, material, and scarce equipment. Call any Standard Oil Company (Indiana) office, or write 910 S. Michigan Avenue, Chicago 5, Ill., for the Engineer nearest you. In Nebraska, write Standard Oil Company of Nebraska at Omaha 2.

Knocks the peaks off of power demand. Better lubrication pays out in many unusual ways. A St. Louis company saves enough on power bills to pay the lubricating costs on two crushers—and then some. A simple change in lubricant did the trick. A Standard Lubrication Engineer thought it up.

The company's power bills were based on an abnormally high demand load. An analysis showed that two crushers were the principal cause. Because they were in an exposed location, starting them, even in moderately cold weather, shot power demands sky high. The Engineer recommended two grades of Stanoil—one for summer and one for winter. These cut the demand load enough to make a substantial reduction on the plant's electric power bill.

These unusual conditions required the *two* grades of Stanoil. Usually, on motors, reduction gears, and other equipment operating in exposed locations, the high viscosity index of Stanoil makes it possible to use only one grade the year around.

Oil is Ammunition . . . Use it Wisely

STANDARD OIL COMPANY (INDIANA) STANDARD SERVICE

★ LUBRICATION ENGINEERING

NG • • LUBRICATION ENGINEERING • • LUBRICATION ENGINEERING • • LUBRICATION ENGINEERING • • LUBRI

Official U. S. Navy Photograph

...BIDDLE INSTRUMENT REPAIR DEPARTMENT

These three "Megger" testers were on board the former liner *Normandie* when she capsized, were recovered after several months and sent to our Repair Department for whatever could be done with them. Although waterlogged and badly corroded, as shown here, we found they could still be salvaged. They were repaired, rebuilt and returned to service, practically equal to new, within three weeks' time—a tribute both to the inherent quality of "Megger" instruments and the craftsmanship of Biddle instrument makers.

For many years we have maintained an Instrument Repair Department for servicing, repairing and rebuilding "Megger" Insulation Testing Instruments, Tachometers, Frequency Meters and other specialties. Today this well-equipped and busy department is not only servicing equipment we have supplied, but also other types and makes of instruments.

Perhaps you have instruments lying idle that need only expert repairing to return them to service. If you are faced with difficulty and delay in procuring replacements, our Repair Department may be able to help you.

THE NEW . . . U. S.-MADE "MEGGER" INSULATION TESTER

in plastic molded case; with the heritage of ruggedness and accuracy common to all instruments bearing the trade mark name "Megger."

Write for new descriptive Bulletin 1735-PE

JAMES G. BIDDLE CO. • 1211-13 ARCH STREET • PHILADELPHIA 7, PENNA.

TAYLOR STOKERS

Meet Fluctuating "Step-ladder" Load in Vital Milk Products Plant

THE steam demands of a certain milk products plant were unusual, complicated by seasonal effects and by the sale of steam to another plant nearby. The load rose and fell in steps during the day.

A Taylor Power Dump Stoker was installed under a 422 H. P. boiler in 1936 and another under a 526 H. P. boiler last year.

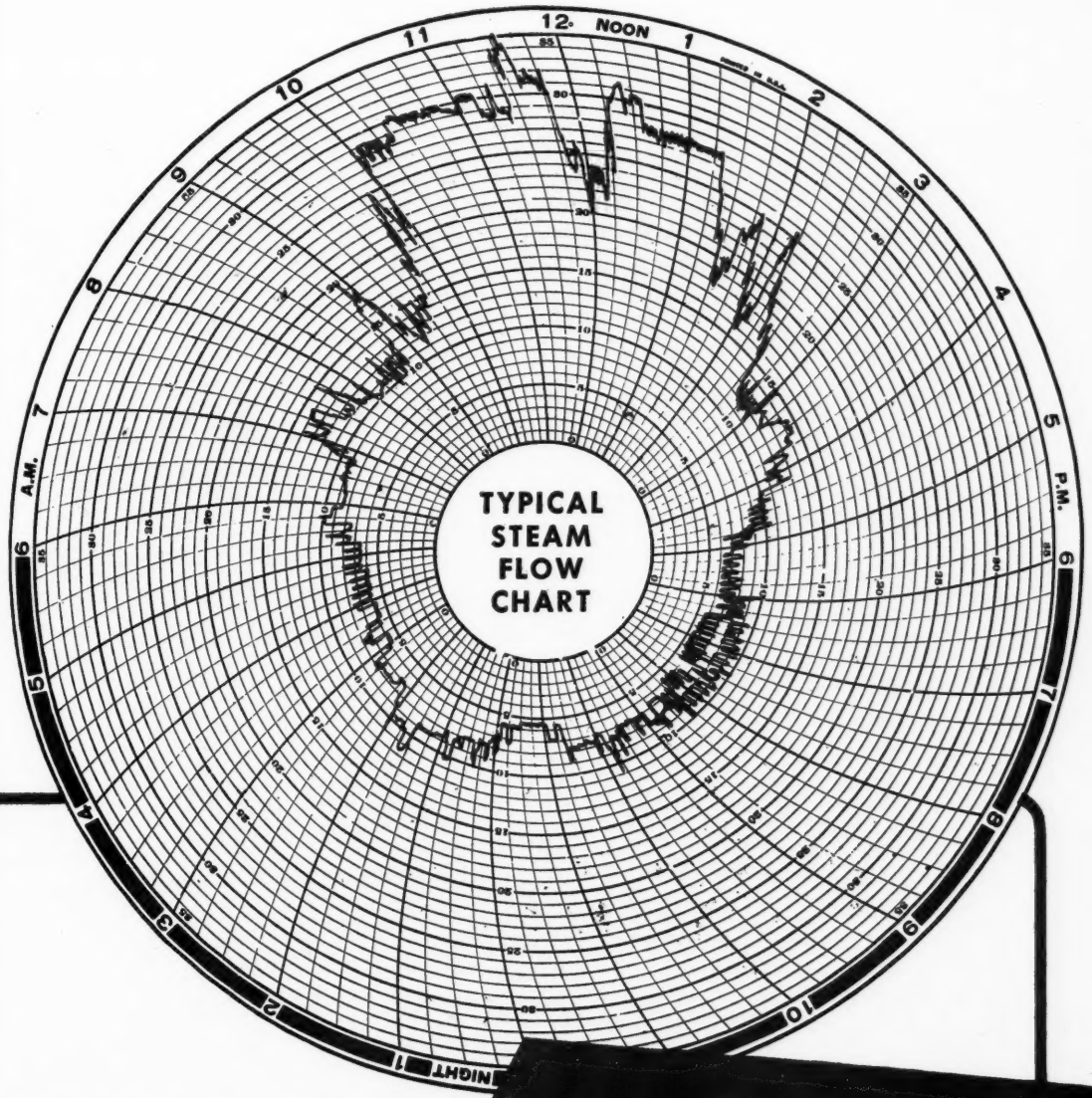
These Taylor Stokers not only follow steam demands of from 5,000 to 35,000 lbs. of steam per hour, but meet these swings and intermediate fluctuations without loss of pressure. The units operate seven days a week, burning coal containing an average of 3% sulphur with exceptional efficiency.

JUDGE THE SELECTION OF FUEL FIRING EQUIPMENT BY THESE TWELVE POINTS

1. **RELIABILITY** —the ability to operate with minimum outage and minimum standby equipment.
2. **CAPACITY** —the ability to provide adequate prime capacity ratings, with sufficient reserve capacity for emergencies.
3. **MAINTENANCE** —the ability to operate continuously with minimum repair costs.
4. **FLEXIBILITY** —the ability to follow the steam demand upward or downward . . . quickly and without sacrificing efficiency.
5. **EFFICIENCY** —the proved dollar efficiency (total cost of steam production) as shown by actual performance in similar installations.
6. **OPERATION** —the ability to operate continuously, the number and type of operations required, the ease of combustion adjustments, etc.
7. **ADAPTABILITY** —the ability to meet special and limiting conditions, present and future—structural limitations, utilization of present equipment, growth and change of power service demands.
8. **FUEL FLEXIBILITY** —the ability to burn efficiently and easily fuels from many sources having widely varying characteristics.
9. **REFUSE DISPOSAL** —the ability to economically eliminate ash or refuse and the opportunities of disposal at low cost, no cost, or profit.
10. **STACK DISCHARGE** —the practical elimination of "smoke nuisance" without special equipment.
11. **SPACE REQUIREMENTS** —the ability to conform to existing or future space limitations, to short and wide or long and narrow furnaces. Also the accessibility of component parts for maintenance and operation.
12. **OBSOLESCENCE** — the adaptability of the equipment toward possible future modernization with minimum of complication and outage.

AMERICAN ENGINEERING

PHILADELPHIA • PENNSYLVANIA

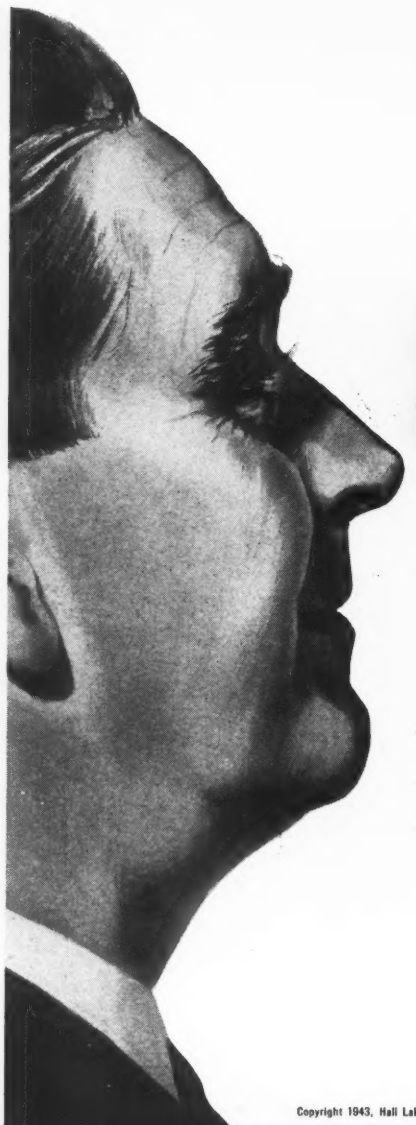


A-E-CO TAYLOR STOKERS
LO-HED HOISTS
HELE-SHAW FLUID POWER
MARINE DECK AUXILIARIES

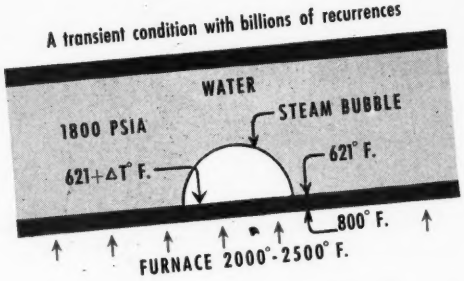
A-E-CO
TAYLOR STOKER

COMPANY

AE CO 75th ANNIVERSARY



The most on boiler water



THE HEART OF THE PROBLEM!

The bubble of steam leaving a strongly-heated tube surface represents but a part of the physico-chemical process taking place. At the metal surface there develops concurrently a film of water containing more of each ion than does the body of the boiler water. The external factors which determine the limit to which this concentration may go are the temperature produced in the concentrating film and the mixing of this film with the more dilute water rushing past it. Whether or not the steel will be wasted away by reaction with the water, whether or not siliceous scales will form a hard, dangerously insulating coating, depends directly upon *control* of the physico-chemical equilibria *in the concentrating film*. Hall Research Laboratories now announce the revolutionary means through which they can effect that control.

Copyright 1943, Hall Laboratories, Incorporated

Unique advantages of the new P-T-X System

as developed by Hall Laboratories

1 Siliceous scales can be reduced or eliminated in the boiler proper because, in the concentrating-film boiler water, potassium silicates have high solubilities increasing markedly with temperature, as compared with sodium silicates, whose solubilities are lower and decrease with temperature.

2 Corrosion and embrittlement. The highly-soluble potassium salts have the advantage in setting up conditions for reducing corrosion from bonded oxygen and minimizing any tendency toward embrittlement.

3 Deposition in superheaters can be controlled more effectively by maintaining equilibria designed to keep any unavoidable carryover in harmless form.

4 Hide-out can be reduced and practically eliminated because the potassium salts concerned are more soluble than the corresponding sodium salts. (See 1.)

5 Turbine conditions can be improved by recognizing the special factor of decomposition of silicates with decreasing temperature and taking measures to oppose this with suitable alkalinity.

6 Toleration of silica permits adequate control of magnesium ion by insuring the presence of enough silica to result in removal as nonadherent magnesium silicate.

7 Circulation is improved because siliceous scale formation, accumulation of iron-oxide and deposition from hide-out are reduced.

8 Higher boiler ratings are possible without difficulty from deposition or attack of steel.

9 Elaborate and costly silica removal equipment should be unnecessary except in unusual cases.

important announcement

conditioning in 20 years

NEW HALL P-T-X SYSTEM offers a revolutionary solution for the problems of siliceous scales and corrosion from bonded oxygen *

With repeated insistence, engineers have been asking experts on water conditioning if they had reached the end of their resources—if there were no chemical answers to attack by boiler water on clean tubes subjected to severe radiation or to deposition of siliceous deposits in boilers and turbines.

NOW, HALL LABORATORIES, AFTER YEARS OF SCIENTIFIC SEARCH AND MORE THAN A YEAR OF ACTUAL FULL-SCALE PLANT EXPERIENCE, ANNOUNCES:

1 The *first* comprehensive system of boiler-water conditioning based on what actually happens in the concentrating film of boiler water on a tube surface, the carry-over into a superheater, the condensing vapor in a turbine.

2 The *first* recognition of the advantages of maintaining boiler-water equilibria dominated by potassium rather than sodium ion, based on the vast differences in properties of certain potassium and sodium salts, particularly the silicates.

3 The *first* method of limiting caustic attack on steel in the concentrating film on a tube surface while maintaining beneficial caustic alkalinity in the body of boiler water.

4 The *first* method of controlling equilibria in the boiler to make silica a useful ally in the boiler water instead of a dreaded enemy.

5 The *first* scientific basis for establishing equilibria in the turbine to control deposition of insoluble silica.

The theories underlying this development have not only been tested in laboratory equipment which captures on a small scale the conditions of temperature, pressure and concentration existing in a boiler, but have been proved in some of the nation's largest boiler plants where this treatment is now in effect.

This new development has come through its "acceptance tests" with startling success. Today, Hall Laboratories is ready with the accumulated experience and the trained personnel necessary to place Hall P-T-X System in operation wherever it is necessary to keep vital war plants in continuous operation.

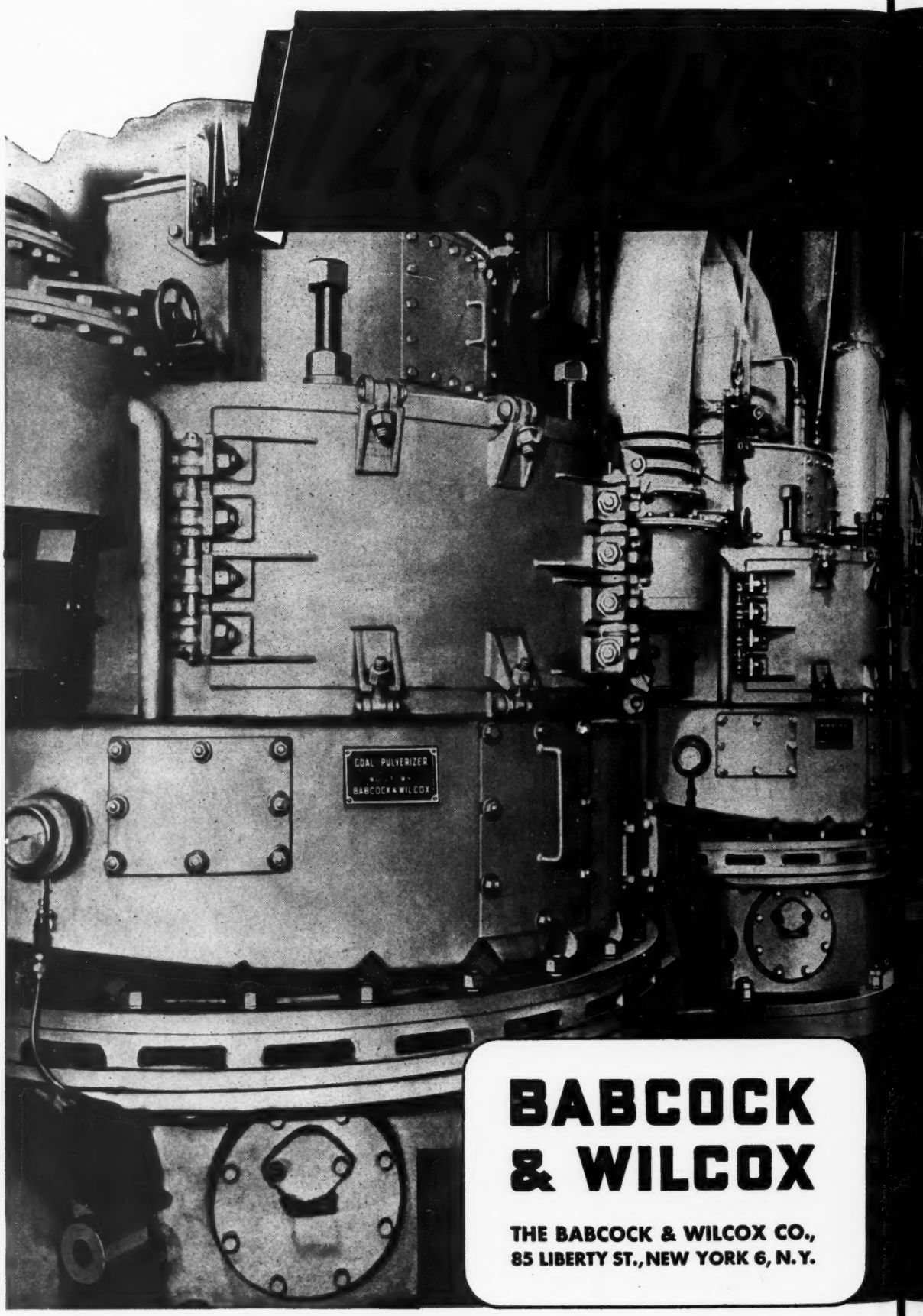
HALL LABORATORIES, INC.

Subsidiary of Hagan Corporation · Hagan Building, Pittsburgh (30), Pa.

HAGAN
HALL
BUROMIN
CALGON

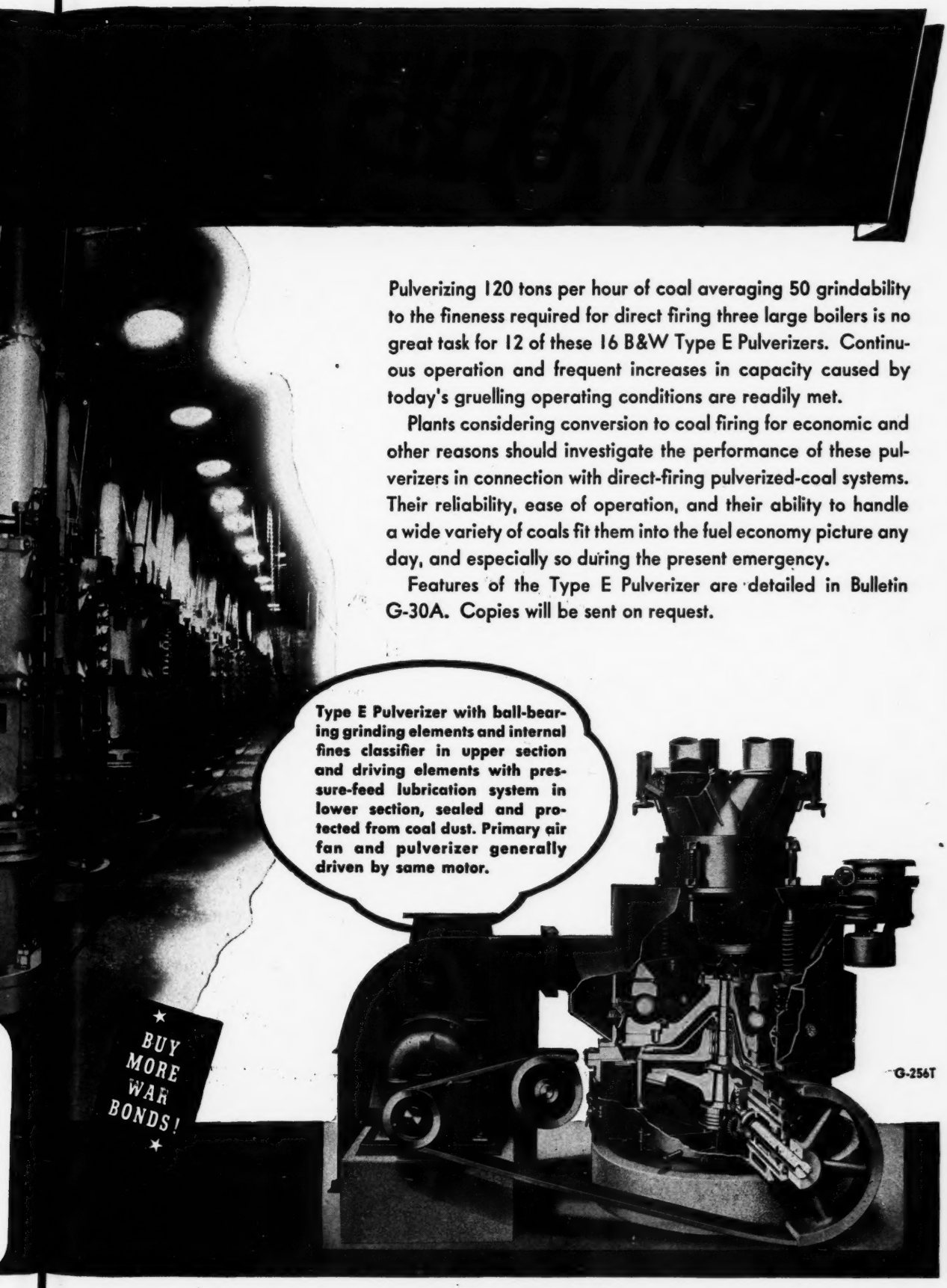
**First announced by Dr. R. E. Hall of Hall Laboratories, Inc. in a paper presented before the American Society of Mechanical Engineers, Nov. 30, 1943.*

HALL SYSTEM *of Boiler Water Conditioning*



BABCOCK & WILCOX

THE BABCOCK & WILCOX CO.,
85 LIBERTY ST., NEW YORK 6, N.Y.



Pulverizing 120 tons per hour of coal averaging 50 grindability to the fineness required for direct firing three large boilers is no great task for 12 of these 16 B&W Type E Pulverizers. Continuous operation and frequent increases in capacity caused by today's gruelling operating conditions are readily met.

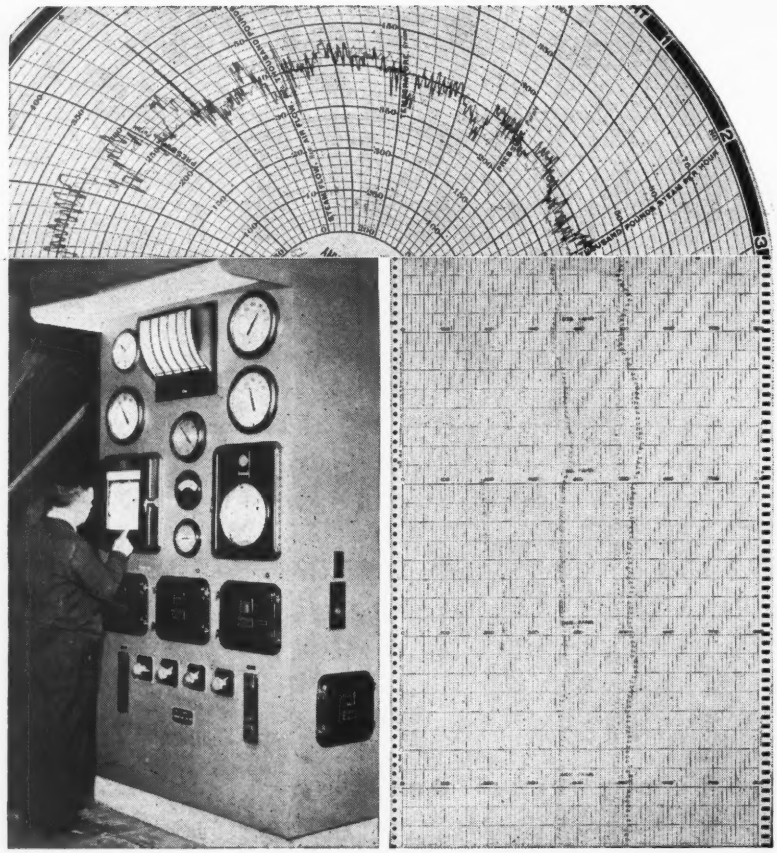
Plants considering conversion to coal firing for economic and other reasons should investigate the performance of these pulverizers in connection with direct-firing pulverized-coal systems. Their reliability, ease of operation, and their ability to handle a wide variety of coals fit them into the fuel economy picture any day, and especially so during the present emergency.

Features of the Type E Pulverizer are detailed in Bulletin G-30A. Copies will be sent on request.

Type E Pulverizer with ball-bearing grinding elements and internal fines classifier in upper section and driving elements with pressure-feed lubrication system in lower section, sealed and protected from coal dust. Primary air fan and pulverizer generally driven by same motor.

G-256T

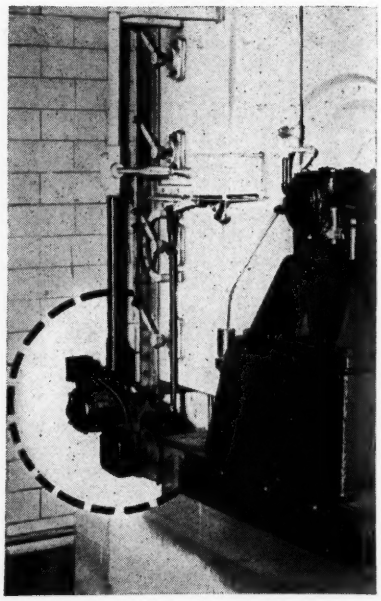
★ BUY MORE WAR BONDS! ★



Top—Bleeding of turbines for process steam causes the swings shown on Utica Knitting Co.'s stoker-fired boilers.
Left—Boiler Panel with Metermax Combustion Control and Micromax Temperature Recorder.
Right—Typical section of Micromax Chart.

depends on me!

A Slogan For Every American



Metermax-controlled Electric Drive Unit on inlet vanes of forced-draft fan.

HIGH BOILER EFFICIENCY?

Utica Knitting Co. Gets It With Metermax Combustion Control

Faced a few years ago with heavier demand for its products, the big Utica (N. Y.) Knitting Co. translated that demand into steam, took a careful look at its steam plant, and decided to install more capacity—at once. Out came some old boilers, up went a new building, and into it went a 50,000 lb/hr C. E. stoker-fired boiler, to supply 225 lb steam at 100 degrees superheat.

Prominent among the problems to be solved was, of course, how to operate this big unit? How to give U. K. Co.'s firemen the kind of help they would need with a boiler so totally different from the ones they were used to? How to operate this unit in parallel with their remaining older and much smaller boilers?

The answer is in the pictures herewith. Metermax Combustion Control has the flexibility that boiler operators need; any adjustment can be changed at any time; the unit can be returned partly or entirely to manual control by turning a single switch on the boiler panel.

And Metermax has the sensitivity needed for efficiency; the full sensitivity required for powdered-coal boilers in central stations is built into every Metermax.

Furthermore, Metermax is simple; its controllers are pneumatic-electric; and its drive units are entirely electric. No line shafting; no hydraulic or pneumatic lines; no connection between panel and drive unit except a single conduit run.

The Metermax Panel reaches you complete, ready for outside connection to fans, feeders, etc. We will if you wish assemble and mount all gauges, indicators and other accessories. We do excellent work of this kind!

If you have a boiler-control problem, outline it and an L&N engineer will gladly try to help. Or if a compact, fully-illustrated catalog will meet your needs, ask for N-01M-163.

TYPE P COMBUSTION CONTROL; COMPANION TO METERMAX

If your plant does not require the central-station characteristics of Metermax Combustion Control, we recommend Type P Control. It is simple, sensitive and thoroughly dependable. Ask for Catalog N-01P-163.

3rd Ad N-01M-163(1)

LEEDS & NORTHRUP COMPANY, 4973 STENTON AVE., PHILA., PA.

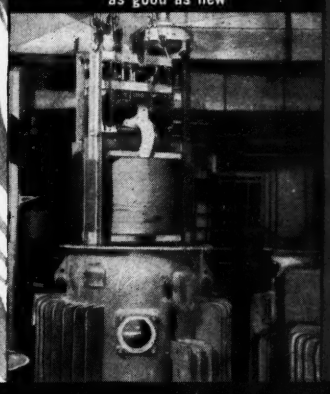
LEEDS & NORTHRUP

MEASURING INSTRUMENTS · TELEMETERS · AUTOMATIC CONTROLS · HEAT-TREATING FURNACES

3 Pictures Worth 30,000 Words of Proof That:

"Pyranol transformers cannot burn or contribute to a fire"

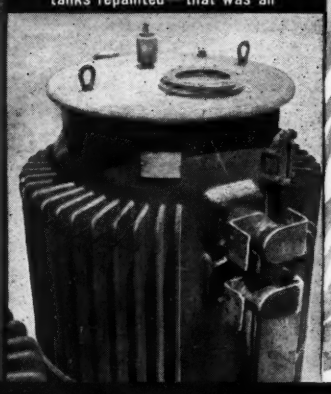
Core and coils were found as good as new



They stood up under fire

They came through a $50,000 fire virtually unharmed. Although surrounded by flame, they did not add to the fire.

Several bushings had to be replaced, and tanks repainted — that was all



ONE of the many benefits to be obtained from the installation of Pyranol* transformers was amply demonstrated recently when 12 Pyranol units were subjected to a severe external fire at a new war plant in the South.

From the field engineer's description of the fire, it is obvious that transformers without non-inflammable liquid, subjected to the same conditions, would have been almost a total loss. And it has been estimated that, with some types of transformers, the damage to the plant might have run as high as half a million dollars.

Reg. U. S. Pat. Off.

The only reconditioning found necessary was the replacement of several bushing porcelains which were cracked by the heat, the painting of the tanks, and the addition of a small amount of new Pyranol to make up for that lost through the bushings.

The transformer interiors were in perfect condition. It was not even necessary to filter the Pyranol.

Here's an experience that proved the wisdom of investing in Pyranol transformers, from the standpoint of safety and reduction of losses from fire. ***General Electric Company, Schenectady, N. Y.***

GENERAL ELECTRIC

402-63-5100

Every week 192,000 G-E employees purchase more than a million dollars' worth of War Bonds

"KNOW HOW!

TO GET THE MOST OUT OF YOUR *Packings*"

With materials shortages, the Packing Industry faces a difficult task—to supply Industry with packings so vital in our War Effort. Naturally this is being done, but not without difficulties promoted by present conditions.

Under these circumstances, knowing how to get the most out of your packings takes on new importance. Through proper packing, conserved wisely, machines can be kept running efficiently at less cost. 'Know How' simplifies packing difficulties; points the ways and means to conserve vital packings; and, reduces packings problems to a minimum.

To help you get the most out of your packings, Belmont Packings, as a service to you, suggest below ways to make your packings last longer:—

1. **CONSERVE PACKINGS**—When repacking, it may be found that a few rings of new packing inserted next to the gland may give added service. This will mean conservation of old packing retained in the stuffing box.

2. **LUBRICATE MOVING PARTS**—Keep rods, shafts and plungers thoroughly swabbed with oil or grease to alleviate frictional wear on packing. Where practicable, install oil lanterns.

3. **CHOOSE SUBSTITUTE CONSTRUCTIONS**—When material shortages make your desired type not instantly available, consult with your nearest Belmont distributor or with us for guidance on this question.

4. **REFER TO THE BELMONT CATALOG**—It's an invaluable packing guide of complete information on packings for all services... it contains informative charts; clearly illustrates and describes every Belmont packing; and suggests varied packing styles from which to choose a substitute packing, if necessary. Write on your Company letterhead for your copy.

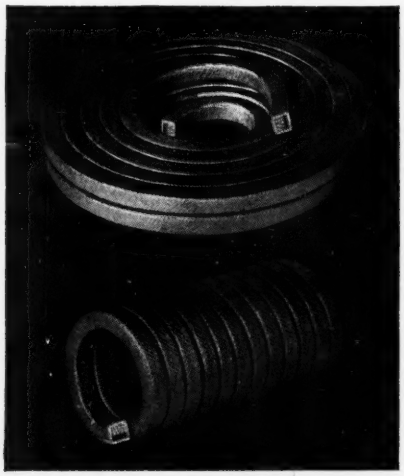
BELMONT PACKINGS

The Belmont Packing & Rubber Co.

Butler and Sepviva Sts., Philadelphia 37, Pa.

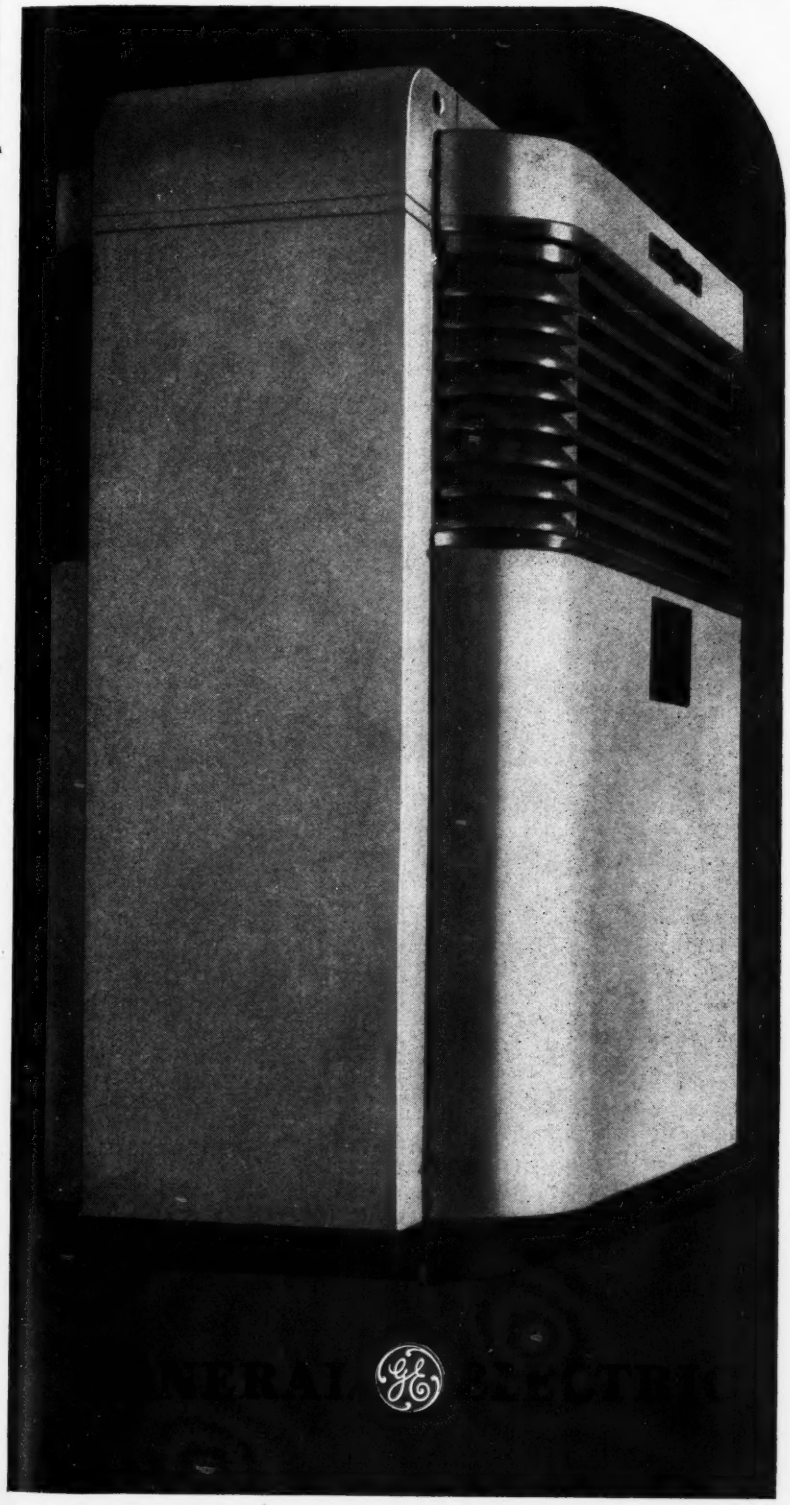
THE BELMONT PACKING & RUBBER CO. — BELMONT — PHILADELPHIA, U.S.A.

There's a Belmont Packing for every service... Steam, Water, Oil, Gas, Air, Acid, Alkalis, and Ammonia. Forms include Rings, Coils, Spirals, Reels, Spools, Sheets, and Gaskets.



REDESIGNED

For greater safety, for speedier installation



THE DRY-TYPE TRANSFORMER of the FUTURE is available NOW

THIS ultramodern distribution transformer is not just a postwar gleam in a designer's eye. *It's an actuality.*

Such transformers are now available for use on 601- to 15,000-volt primary circuits, in ratings from 100 to 500 kva.* We offer them at this time because they afford greater safety and speedier installation than previous dry-type designs—both vitally important today.

For 50 years General Electric has built dry-type transformers. But in designing these streamlined units, we threw tradition to the winds. For indoor installations in industrial plants, their metal-enclosed construction offers a greater degree of safety than the former, open-screened design. Also, the unique housing provides the advantages of enclosed terminals, so arranged as to permit speedy installation.

There are undoubtedly many questions that you'd like to ask about their construction features—features that make for ready accessibility of all parts, excellent ventilation, ease of installation, and safety. You'll find all these questions answered in our new bulletin. Ask for a copy. ***General Electric Co., Schenectady, N. Y.***

****G-E dry-type transformers are also available in certain sizes larger than 500 kva.***

Bulletin GEA-37148

DRY-TYPE TRANSFORMERS

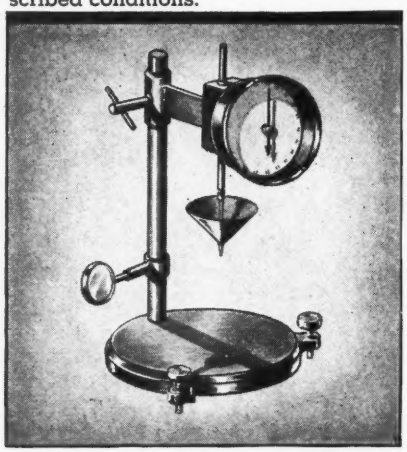
402-64-5100

Every week 192,000 G-E employees purchase more than a million dollars' worth of War Bonds

PENETRAM

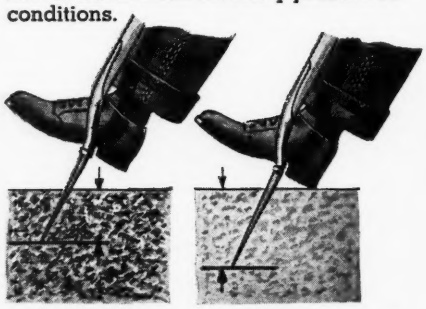
TIDEWATER LUBRICANIA

DEFINITION: The consistency or hardness of lubricating greases is generally expressed by the depth to which a standardized cone-shaped weight will penetrate the grease under definite prescribed conditions.



PENETRATION TEST: Following a carefully prescribed procedure the grease is brought to a temperature of 77°F. and the tip of the penetrometer cone is lowered until it just touches the surface of the grease. The cone is then quickly released for five seconds and the depth of travel of the cone is carefully noted. The average of five such tests at different points of the grease surface, measured in tenths of a millimeter, is reported as the Penetration or Consistency of the grease at 77°F.

If the grease was not worked before the test, it is reported as the "unworked" consistency. If the "worked" consistency is to be determined, the sample is first worked under carefully prescribed conditions.



EXAMPLES:

	A.S.T.M. "Worked" Consistency (77° F.)
Soft (No. 1) Cup Grease	310-340
Medium (No. 3) Cup Grease	220-250
Heavy (No. 4) Cup Grease	175-205
Hard (No. 6) Cup Grease	85-115

SIGNIFICANCE: The "worked" penetration is an indication of the tendency of the grease to leak or drip from a bearing, or its ability to flow under pressure in feed lines. However, the resistance to flow through narrow bearing clearances or the ability to support bearing loads are more nearly proportionate to the viscosity characteristics of the oil used in the manufacture of the grease. The "unworked" penetration of greases is subject to many variables and except for very hard greases has little significance.

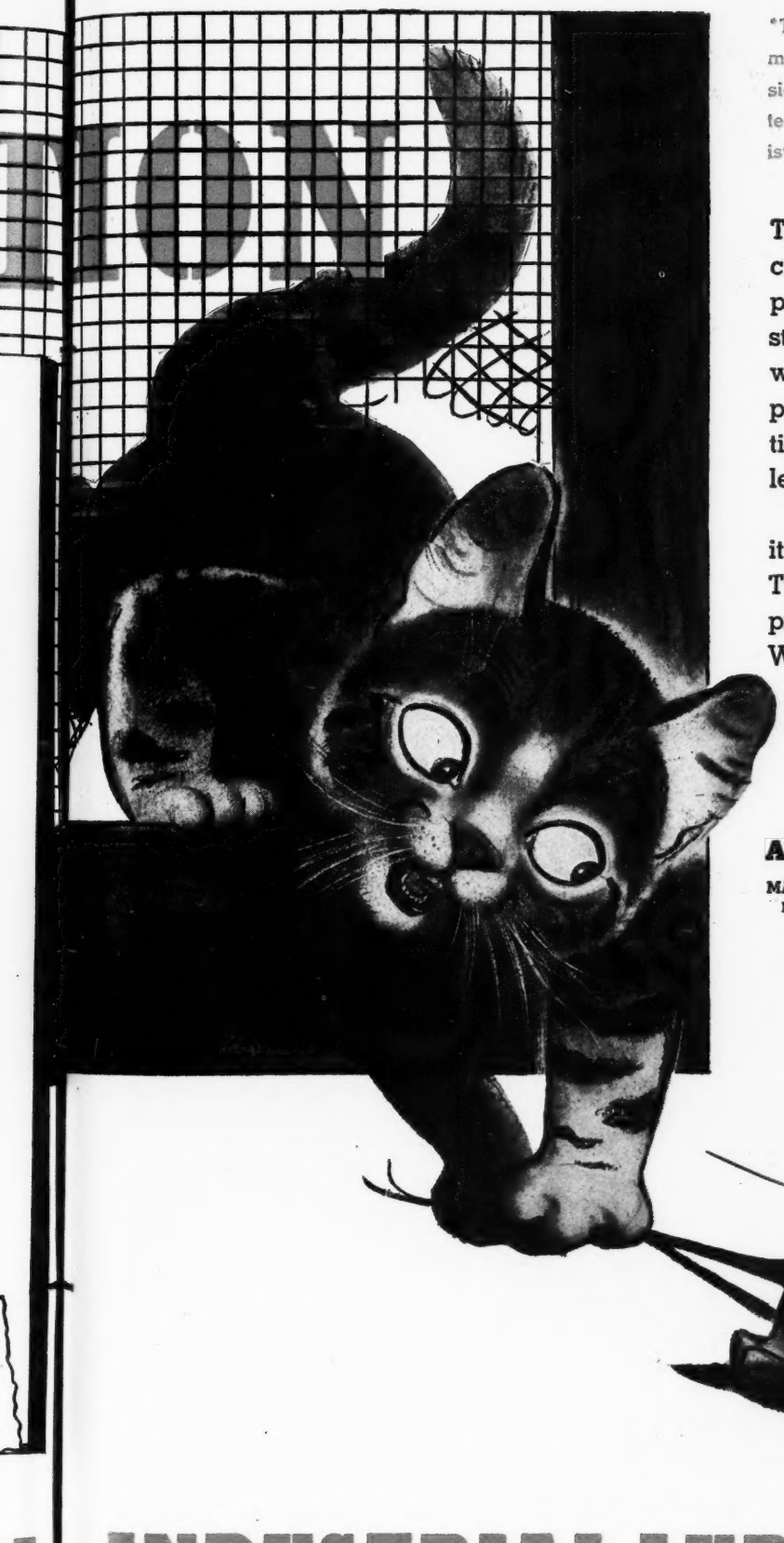
OIL IS AMMUNITION
USE IT WISELY!

DRUMS! DRUMS! DRUMS!
War needs make it extremely important that all empty drums be returned immediately.

INDUSTRIAL TYCOL OILS-GREASES

SCIENTIFICALLY ENGINEERED FOR EVERY INDUSTRIAL USE

TYCOL



*This is the 7th of a series of informative messages concerning the meaning and significance of commonly used tests and terms employed to describe the characteristics of lubricating oils.

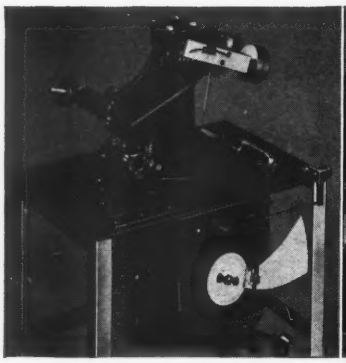
Tycol greases are scientifically compounded for all lubricating purposes, from textile spindles to steel rolling mills. Tycol greases when used for the recommended purpose afford maximum lubrication with minimum friction and leakage.

Whatever you need — whether it be a lubricating oil or grease — Tycol lubricants provide complete protection at low cost. Let a Tide Water engineer help you select the lubricant best suited to your job.

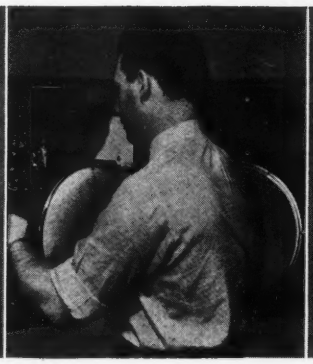
TIDE WATER
ASSOCIATED OIL COMPANY

MAKERS OF THE FAMOUS VEEDOL MOTOR OIL
Eastern Division: 17 Battery Place, New York 4, N. Y.
Principal Branch Offices:
Boston, Philadelphia, Pittsburgh, Charlotte, N. C.

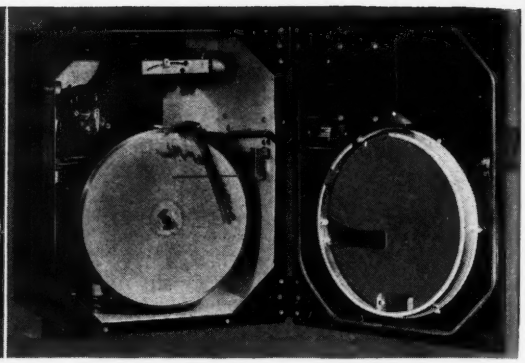
INDUSTRIAL LUBRICANTS



Meter assembled as one unit on rack ready for calibration.



Meter assembly can be easily removed from the case.



Meter with door open showing accessibility of all adjustments and working parts.

Republic Boiler Meter

ON ONE CHART ○ STEAM FLOW
AIR FLOW
TEMPERATURE
OR PRESSURE

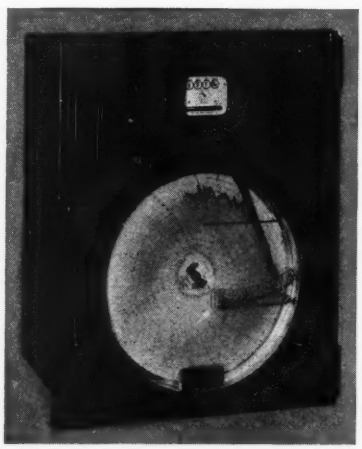
★ The new Republic Boiler Meter provides, in one instrument and on one chart, all the essential information concerning boiler performance regardless of the size or type of boiler, kind of fuel or method of firing.

The meter indicates, records, and integrates steam flow from the boiler and records rate of air flow for combustion. When the correct amount of air for maximum combustion efficiency is being supplied the air flow pen will record coincident with the steam flow pen, regardless of the load being carried by the boiler.

A third pen recording flue gas temperature (or steam pressure) can be added thereby providing the operator with complete information, on one 12-inch chart, relative to the performance of the boiler at any given time.

The Republic Boiler Meter consists of a standard Republic electric steam flow recorder and integrator and an oil sealed, bell type air flow element.

The air flow element consists of an oil sealed bell in a sealed chamber. The motion of the bell is transmitted through a diaphragm seal. This arrangement permits the use of a single bell—the high pressure being applied to the top of the bell and the low pressure under the bell. This arrangement also excludes air and dirt from the oil. The motion of the bell is transmitted to a cam system which extracts the square root, or when adjusted for a particular installation, compensates for chimney action and variable excess air requirements. The air flow pen is attached to the cam system with an adjustable linkage which permits changing the steam flow air flow ratio as conditions may require.



The entire operating mechanism is housed in a rugged steel case and can be easily removed as a single unit by merely loosening two anchor bolts and disconnecting the two air connections. The meter may be either wall mounted or flush mounted on a steel panel. *Write for Bulletin No. 420.*

REPUBLIC FLOW METERS CO.

2224 DIVERSEY PKWY. CHICAGO 47, ILLINOIS

A LESSON IN WATER COOLING

LESSON 9 OF A SERIES

HOT AIR RECIRCULATION

"Hot air recirculation" is an undesirable condition which occurs at intervals or continuously in those mechanical draft cooling towers not properly designed to prevent it. It is the re-entry, into the tower's fresh air intakes, of discharged air which is heat-laden from previous passage through the tower.

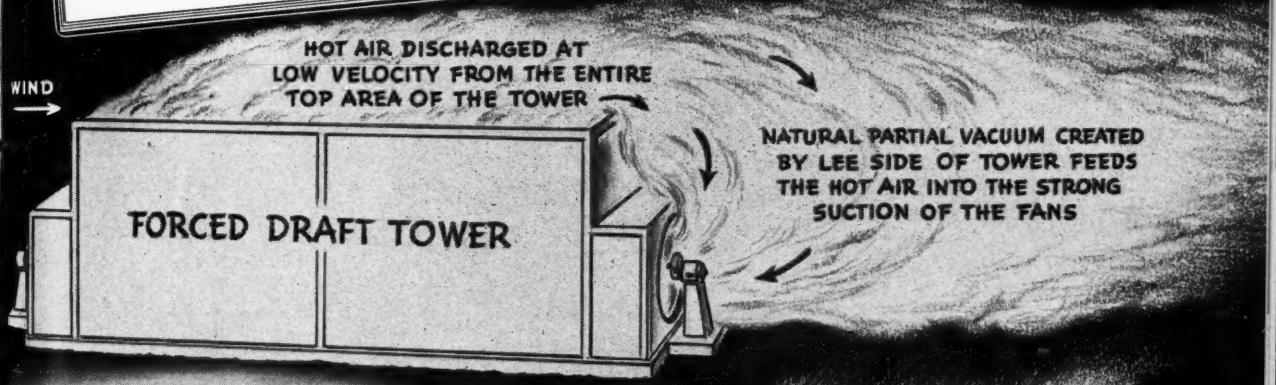
The net result of recirculating hot used air is to increase the wet bulb temperature and total heat content of the entering air. Its effectiveness as a cooling medium is thus reduced, causing the water temperatures to rise.

Recirculation of hot air increases water temperatures from a fraction to as much as 6 or 7 degrees in extreme cases. The following example is typical of the effect of recirculation upon cooling tower performance and investment:

	Performance as Designed	Performance with Recirc.
Hot water temperature	98 F	100.0 F
Cold water temperature	80 F	82.0 F
Wet Bulb temperature	73 F	75.5 F
Loss of tower effectiveness	0%	15%
Loss of investment	0%	15%

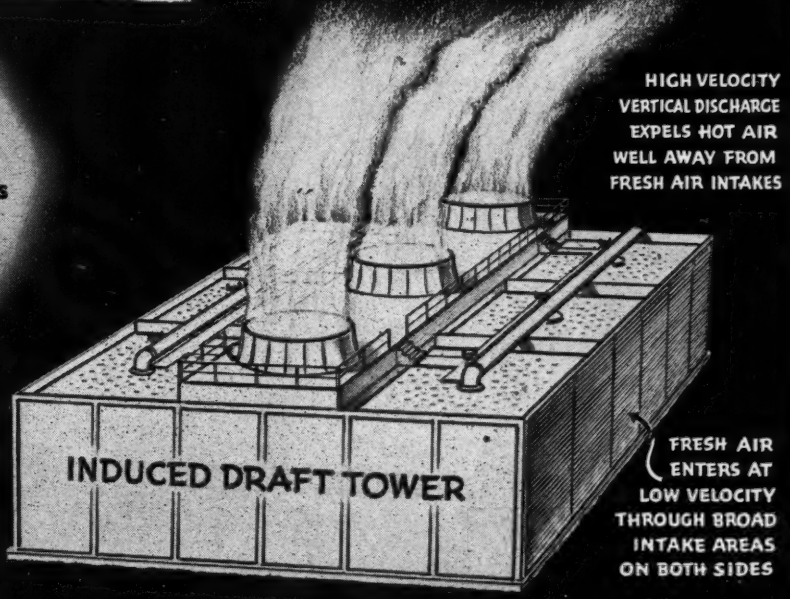
This negative feature of mechanical draft cooling towers is confined almost entirely to the forced draft type, particularly those having large fans and great width. The low discharge velocity of the hot used air leaving the broad top area of the forced draft tower permits it to be easily blown, by external winds, into the suction of the forced draft fans.

The induced draft type of cooling tower, with fans discharging vertically at great velocity, expels the hot used air high into the atmosphere and away from the fresh air inlets.


WIND
HOT AIR DISCHARGED AT LOW VELOCITY FROM THE ENTIRE TOP AREA OF THE TOWER
NATURAL PARTIAL VACUUM CREATED BY LEE SIDE OF TOWER FEEDS THE HOT AIR INTO THE STRONG SUCTION OF THE FANS
FORCED DRAFT TOWER

FACTORS CONTRIBUTING TO HOT AIR RECIRCULATION IN FORCED DRAFT TOWERS:

1. High velocity cross-wise winds
2. Extreme width
3. Fans on both sides of tower
4. Improper location with respect to other structures


HIGH VELOCITY VERTICAL DISCHARGE EXPELS HOT AIR WELL AWAY FROM FRESH AIR INTAKES
INDUCED DRAFT TOWER
FRESH AIR ENTERS AT LOW VELOCITY THROUGH BROAD INTAKE AREAS ON BOTH SIDES

MARLEY COOLING TOWERS

THE MARLEY COMPANY INC.
KANSAS CITY, KANSAS

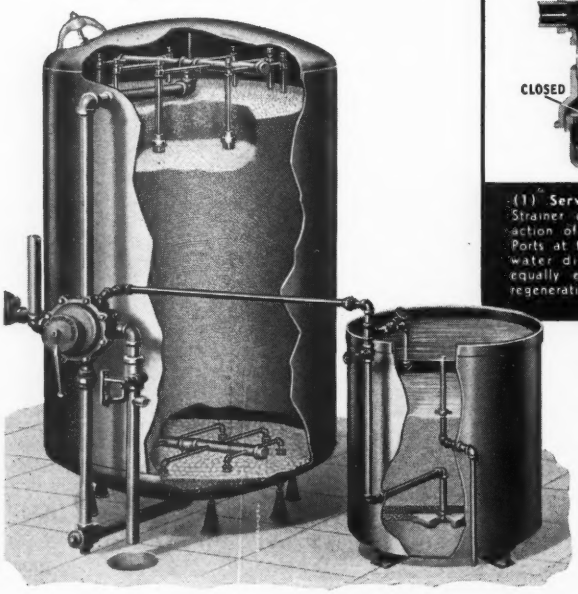
"44% more capacity"

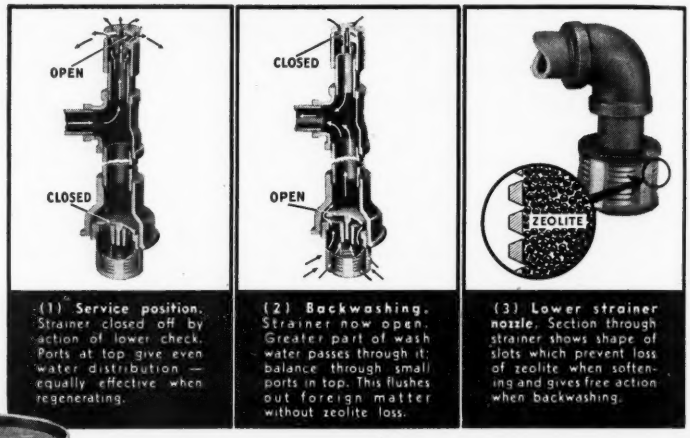
—say more than 2200 users of the

ELGIN DOUBLE W CHECK

ZEOLITE WATER SOFTENER EQUIPMENT

Double-Check Manifold can be installed in any make of softener





(1) **Service position.** Strainer closed off by action of lower check. Ports at top give even water distribution — equally effective when regenerating.

(2) **Backwashing.** Strainer now open. Greater part of wash water passes through it; balance through small ports in top. This flushes out foreign matter without zeolite loss.

(3) **Lower strainer nozzle.** Section through strainer shows shape of slots which prevent loss of zeolite when softening and gives free action when backwashing.

THESE ARE THE ADVANTAGES YOU GET:

- **Up to 44% more softened water**
- **Prevention of zeolite loss**
- **Less salt consumption**
- **No packing or channeling**
- **More thorough backwashing**
- **Self-cleaning action**

A SMALL CHANGE MAKES A BIG DIFFERENCE

THE big difference is summed up in those six advantages listed above. Check them over. They are fully confirmed by a long list of users who report up to 44% more soft water output from a softener of given size along with reduced salt consumption and minimum loss of zeolite.

The small change is the Elgin Double-Check manifold explained by the illustrations above. The equipment is at its best as a part of the new Elgin Double-Check Softener, but you can obtain a remarkable increase in the capacity and efficiency of your present softener (any make) by having it installed as here illustrated and described. The primary purpose of the Double-Check manifold is to permit a *higher bed of zeolite* in a given size tank—and of course it's the zeolite that does the work. Former attempts to increase the amount of zeolite in softeners of conventional design have resulted in a loss of zeolite to the drain when backwashing. The only way to prevent this loss and still have a sizeable bed, was by reducing the backwash flow rate. But this slow rate was insufficient to properly clean the zeolite, and, worse still, permitted packing and channeling of the bed.

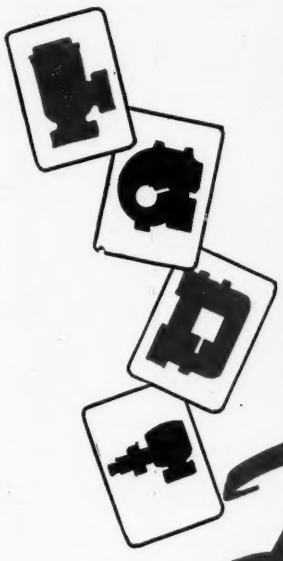
The Double-Check manifold has changed all this. It stops the escape of zeolite despite the far deeper bed carried. As a result, a rapid backwash rate can be used, cleaning the zeolite fully and loosening it up uniformly so that the salt solution can readily surround the grains of zeolite and regenerate them far more efficiently. Still another ingenious feature is the method of eliminating suspended impurities through the ports in the top of the upper manifold system.

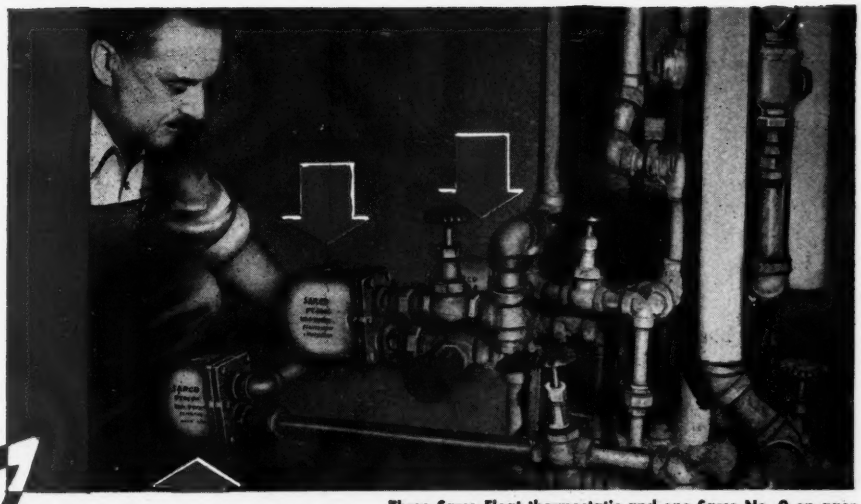
The detailed story of these and other features of the Double-Check equipment is told in a new bulletin that is yours for the asking. Write today for your copy.

Modernize Your Water Softener With Double-Check Manifold

The Double-Check manifold is in key with today's program of saving materials by modernizing existing equipment. Let us show you how we can step up the capacity and efficiency of your present softener!

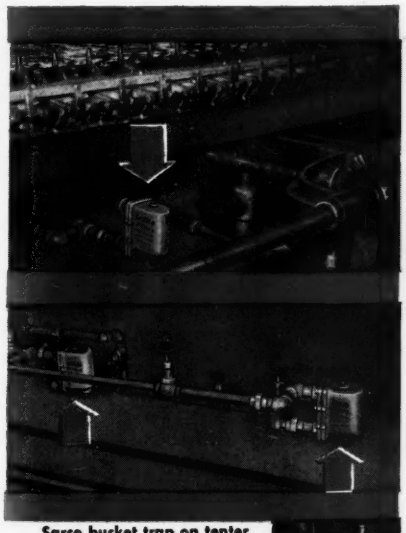
ELGIN SOFTENER CORPORATION, 136 North Grove Avenue, Elgin, Illinois



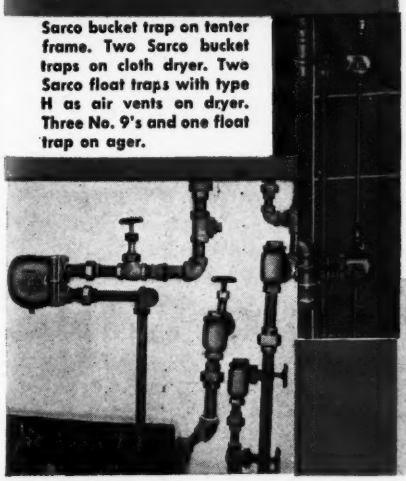


Three Sarco Float-thermostatic and one Sarco No. 9 on ager

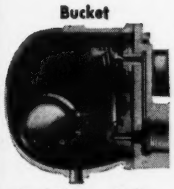
Four SARCO ACES
IN THIS TEXTILE PLANT



Sarco bucket trap on tenter frame. Two Sarco bucket traps on cloth dryer. Two Sarco float traps with type H as air vents on dryer. Three No. 9's and one float trap on ager.

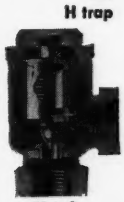


Bucket



Float-thermostatic

H trap



No. 9

If you don't want to gamble with your production output, you will see that every steam operated machine in your plant is provided with *exactly* the right kind of steam trap.

The illustrations show how four different types of Sarco traps work together like a team to provide smooth uninterrupted flow of production in this silk printing plant.

The Sarco No. 9 thermostatic trap is used for steam coils on dryers and similar operations where the load is reasonably steady. The Sarco Bucket trap was selected for the rolls and where the load fluctuates widely. The Sarco Float trap is employed to drain all steam lines and the little Sarco Type H is used for an air vent wherever one is needed.

As individual "Aces", or as teams of four, Sarco steam traps have been meeting industry's needs for a quarter of a century. They are made in a modern factory devoted exclusively to steam traps and temperature control.

The Sarco representative near you can give you the benefit of many years of experience in plants like yours, and can tell you which Sarco trap will be best for each job.

SARCO COMPANY, INC., 475 FIFTH AVENUE, NEW YORK 17 N.Y.
Represented in Principal Cities

SARCO Saves Steam

SARCO CANADA, LTD., 85 Richmond Street, West, TORONTO, ONTARIO 24

● **Eliminate Air**—Cut tube end erosion by installing air and erosion eliminators. These removable screen plates, fitted with air ejection piping, remove air from circulating water before it attacks tube sheets and tube ends. Increase tube life from three to seven times in the average installation.

● **Detect Weak Tubes by Shock Test**—The 10-year-old hydro-dynamic Shock Test destroys tubes just ready to fail. Frequently, less than ten percent of the tubes in large condensers require replacement, but, unless discovered and removed, they will soon necessitate another shut-down and even major overhaul. Only by Shock Test can you mechanically and accurately distinguish good tubes from bad.

● **Stop Tube End Wear**—Use FLOWRITES, replaceable, bell-mouthed sleeves at entrance ends of either new or old tubes. They provide smooth, directed flow of circulating water, eliminating air pockets and preventing air caused erosion of tube ends and pinholes.

● **Stop Tube Leaks—Fast**—The WIZARD Injector and Special Sealing Compound will stop tube leaks in a few seconds.

✔ **Don't Scrap Tubes with Worn Ends**—Even tubes with ends worn through can be salvaged. If they withstand the Shock Test, we can stretch them to usable lengths, cut off the bad ends and return them to service.

* * *

In holding down condenser maintenance costs, the Big League Utilities have kept our facilities and our field crews busy for seventeen years. Today, uninterrupted flow of power for war production is more essential than ever.

Avoid breakdowns and priority holdups by taking advantage of Conseco nation-wide, clock-around service. A letter, telegram or 'phone call will start your job rolling. Estimates furnished for specific work.

Condenser Service
AND ENGINEERING CO., INC.

83 RIVER STREET, HOBOKEN, NEW JERSEY

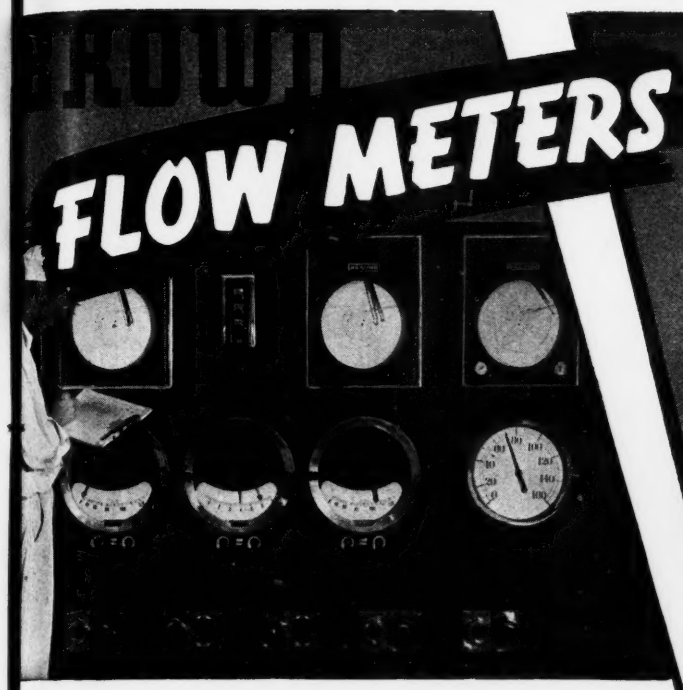
★

NEW JERSEY TELEPHONE—HOBOKEN 3-4425

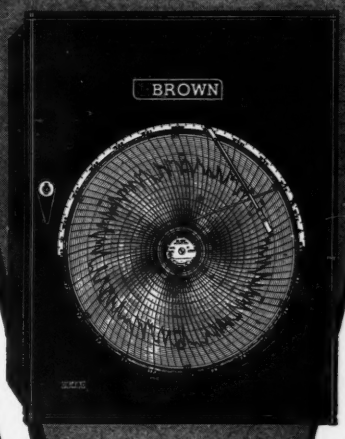
NEW YORK TELEPHONE—RECTOR 2-9360 **AFTER 6 P. M. AND SUNDAYS—HOBOKEN 3-4428**

12-CS-2

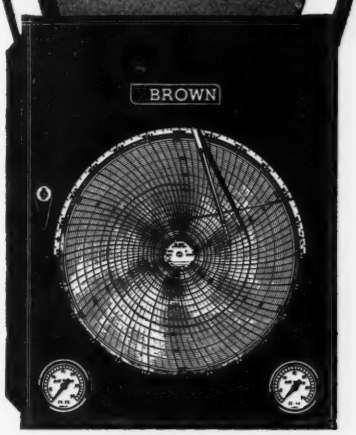
FLOW METERS ...SECURE EFFICIEN POWER PRODUCTIO



INDICATING



RECORDING



CONTROLLING

TO win the war—It is a patriotic duty to *eliminate waste of power.*

To produce and use power more efficiently is the object of every industrial operation. For that purpose, good managers keep chart records of steam, air, oil, gas, water and other fluids.

Whether you buy steam or generate it in your own plant—every pound of steam saved—not only in the boiler room but in every department or unit where steam is used—assures Victory.

With Brown Flow Meters, you can correctly determine the cost of making steam for power, processing or heating and properly allocate costs to departments or units. Brown Flow Meter chart records show the rate of steam flow which enables operators to maintain the most efficient boiler operation, thus effecting substantial fuel savings.

An automatic planimeter pen record on rim of chart shows steam flow in volume units and the time at which it was produced or used in any part of the 24 hour period, and enables management to readily analyze steam production and distribution.

Thousands of plant engineers are getting this invaluable service from Brown Flow Meters. In many plants, the investment for Brown Indicating, Recording and Controlling Flow Meters has been repaid many times over. Write for catalogs.

For Temperatures . . . . . Pressures . . . . . Flows . . . . . Liquid Levels

BROWN INSTRUMENTS

ELECTRIC • AIR OPERATED

THE BROWN INSTRUMENT COMPANY, 4491 WAYNE AVENUE, PHILADELPHIA, PENNSYLVANIA
DIVISION OF MINNEAPOLIS-HONEYWELL REGULATOR CO.
MINNEAPOLIS, MINNESOTA AND 119 PETER STREET, TORONTO, CANADA
Wadsworth Road, Perivale, Middlesex, England
Nybrokajen 7, Stockholm, Sweden

HEAT INTERCHANGE AND VACUUM EQUIPMENT

For Every Power Plant Need

As a major producer of heat interchange equipment, Lummus designs and builds a complete line of

★ Surface Condensers
★ Steam Jet Air Pumps
★ Bleeder Heaters
★ Boiler Blowdown Heat Exchangers
★ Evaporators
★ Fuel Oil Heaters
★ Lubricating Oil Coolers

The services of Lummus engineering personnel are available to public utilities and industrial power plants for the study of specific problems and the design of heat exchange and vacuum equipment to meet individual conditions.

THE LUMMUS COMPANY • 420 LEXINGTON AVE., NEW YORK 17, N.Y.

LUMMUS

Complete Series Yours, FREE!

All 10 Helpful Elevator Rope Reeving Diagrams Now Ready!

We've had many requests for indiyidual reprints of these Elevator Rope Reeving Diagrams which have appeared in Macwhyte Company advertisements.

Now the complete series is available to elevator maintenance men, building owners and managers, superintendents and engineers. Send your request on your company letterhead to the Macwhyte Company, Kenosha, Wisconsin, or to a Macwhyte distributor or mill depot.

Special Bulletin Also Sent Free • Because of many requests, we have also reprinted a special bulletin on elevator rope care. This will be sent along with the above Installation reprints.

The bulletin No. 43-73 includes timely information on proper handling of elevator rope in installation and care of the rope afterwards. Also included is information on diameters, weights, grades, strengths of Macwhyte Elevator Ropes.

More Help, Too • Whether you're using Macwhyte Elevator Ropes or not, if we can be of assistance in helping you get longer service from present ropes, we'll welcome the opportunity. If you are now thinking of new elevator ropes, make sure you look into those made by Macwhyte. These low-cost-per-car-mile ropes, both regular and PREformed, have a national reputation for high quality and smooth operation. Next time, specify Macwhyte PREformed Elevator Ropes.

COVER MOST INSTALLATIONS

The diagrammatic series, prepared by Macwhyte elevator rope engineers, includes installations for:

One to One Double Wrap U Groove Traction Elevator
Two to One Double Wrap U Groove Traction Elevator
Overhead Single Wrap V Groove Traction Elevator
Overhead Two to One Single Wrap V Groove Traction Elevator
Basement Single Wrap Traction Elevator
Overhead Drum Counterweight Elevator
Basement Back Drum Counterweight Elevator
Direct Plunger Hydraulic Elevator
Vertical Geared Side Plunger Hydraulic Elevator
Horizontal Plunger Hydraulic Elevator

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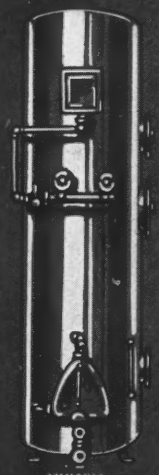
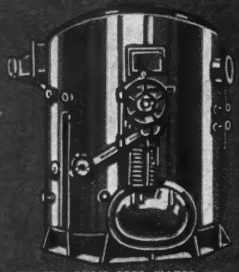
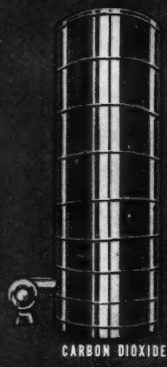
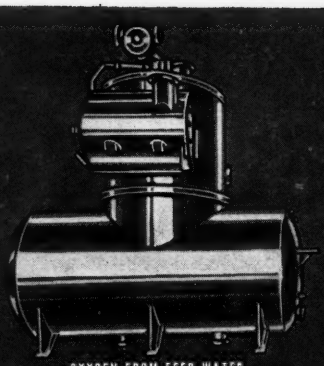
MACWHYTE ELEVATOR ROPES

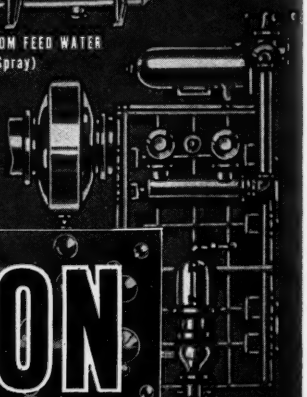
PRE-FORMED FOR per-car-mile BEST PERFORMANCE





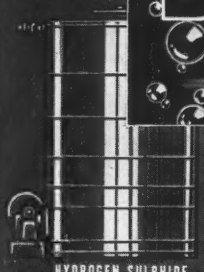




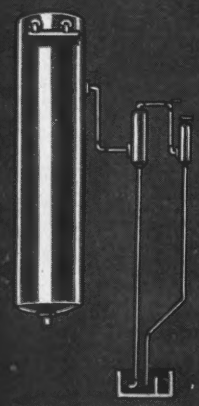


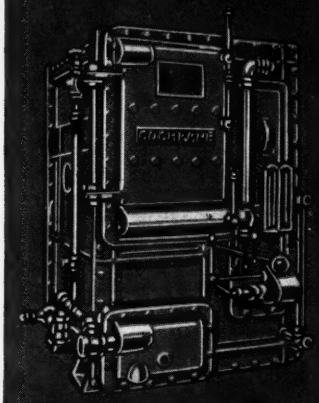
COCHRANE EQUIPMENT FOR THE

DEGASIFICATION OF WATER



SINCE 1885 Cochrane engineers have worked primarily to design and apply equipment for heating, degasifying, and chemically treating boiler feed water. Naturally, in acquiring the experience and data resulting from more than fifty years of such activity, problems have been encountered requiring equipment to condition and degasify water of unusual physical and chemical characteristics. Feed water deaerating equipment has been supplied to operate at pressures ranging from subatmospheric to over 125 lb./sq.in. Equipment for deaerating cold water with temperatures as low as 35°F and other equipment to remove carbon dioxide, hydrogen sulphide and ammonia have been furnished in relatively small as well as in large capacities.





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Right now, this aspect of S-A activity has *double* significance . . . (1) the solution of your present problems . . . (2) the solution of new handling problems connected with new processes and products contemplated for the post-victory world.

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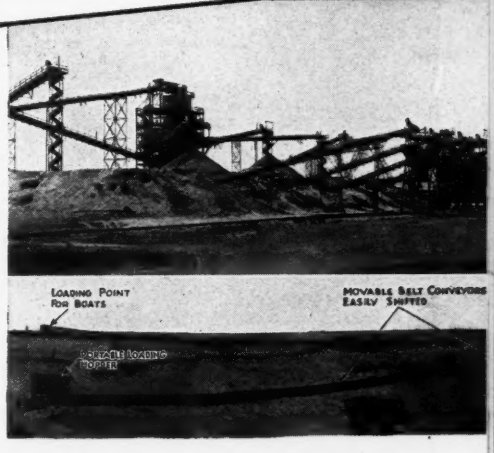

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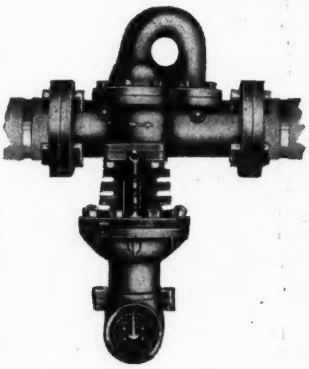
BUILDERS *flo-watch* METER

An accurate, durable, wide range flow meter for *recording, indicating* and *totalizing* the flow of steam. Recommended for steam control purposes where an hour by hour chart record of steam production, distribution or consumption is desired. Builders Flo-Watch is designed and priced for general industrial and power plant application. Write for Bulletin 318-A. Address Builders-Providence, Inc., 9 Codding Street, Providence 1, Rhode Island.

BUILDERS *Shunt* METER



An accurate, dependable flow meter with totalizer onlv. Extensively used by industrial concerns and public utilities for metering steam, air and gas distribution. Builders Shunt Meter reads directly in pounds of steam, bolts into the line like a valve or fitting, uses no mercury, has no clock to wind, and requires no power supply. Write for Bulletin 307. Address Builders-Providence, Inc., 9 Codding Street, Providence 1, Rhode Island.

AWARDED
AUG. 1st, 1942
STAR AWARD
MAY 8th, 1943

Sincerely Yours,

BUILDERS
RECORDING-INDICATING-CONTROLLING
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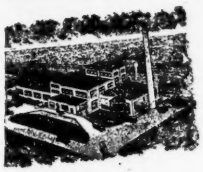
IRON FIREMAN STOKERS SAVE 30% ANNUALLY



SALINE COUNTY MILK PRODUCERS' ASSOCIATION
Telephone - Marshall 162
MARSHALL, MISSOURI

March 3, 1943

Iron Fireman Manufacturing Co.
3170 W. 106th Street
Cleveland 11, Ohio

Gentlemen:

In December 1941 we purchased one Iron Fireman spreader type stoker PSC #8 and were so satisfied with savings in fuel and labor that we purchased another of these stokers in January, 1942.

We had another type of stoker on our boilers previous to this but they were not satisfactory. These old stokers also required 2 X 1¼ inch nut coal which is higher priced than present coal which we now burn--1¼ X 0 screenings.

We not only save fuel and use cheaper coat fuel but these Iron Fireman spreader type stokers are easier to operate and make it much easier to obtain labor as fireman have less hard work to do.

Very truly yours,
SALINE COUNTY MILK PROD. ASSN.
A. M. Rock

A. M. Rock
President

AMR/ml

Manufacturers of "HIGHEST QUALITY DAIRY PRODUCTS"

. . . in "Food for War" plant in Saline County, Missouri

Two Iron Fireman Pneumatic Spreader stokers operate 22 to 24 hours a day—365 days a year—in the plant of the Saline County Milk Producers' Association, which produces dried eggs, dried milk, condensed milk and butter. ★ The Iron Fireman stokers, which are installed in the Brownell boilers, saved $3300 in one year—a saving of 30%.

Iron Fireman stokers burn local coals . . . Help solve manpower problems

Iron Fireman stokers save money and fuel transportation because they burn all types of lower cost local coals. Coal for this plant, for example, comes from nearby Clinton and Moberly, Missouri.

Because the boiler room is clean and the Iron Fireman stokers are easy to operate, A. M. Rock, president of the association, says that it is easier to get and to keep boiler room attendants. Automatic stoker firing releases employes for productive work in the plant.

Iron Fireman Stokers Now Available

The output of Iron Fireman commercial and industrial stokers has been substantially increased. Materials have been made available for producing stokers to convert hand fired jobs which use more than 40 tons of coal a year, and to convert oil and gas fired boiler plants to automatic coal firing.

Investigate what Iron Fireman stokers will accomplish in your own plant. Our nationwide organization of qualified factory representatives and dealers is at your service. Write or wire for information about Iron Fireman stokers, or ask for free engineering survey. Iron Fireman Manufacturing Company, 3522 West 106th Street, Cleveland 11, Ohio. Plants in Cleveland, Ohio; Portland, Oregon and Toronto, Canada.

IRON FIREMAN AUTOMATIC COAL STOKERS

Yarway Impulse Traps

For Pressures Up to 1500 lbs

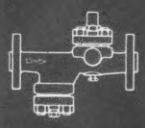


Fig. No. 140 to 147. Medium pressure Integral-strainer Impulse Trap for pressures up to 600 lb. Steel body, flanged connections.

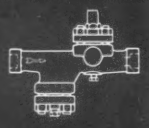


Fig. No. 250 to 257. Medium pressure Integral-strainer Impulse Trap for pressures up to 600 lb. Steel body, socket weld connections.

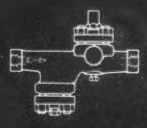


Fig. No. 410 to 417. Low pressure Integral-strainer Impulse Trap for pressures up to 150 lb. Bronze body, screwed connections.

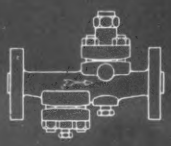
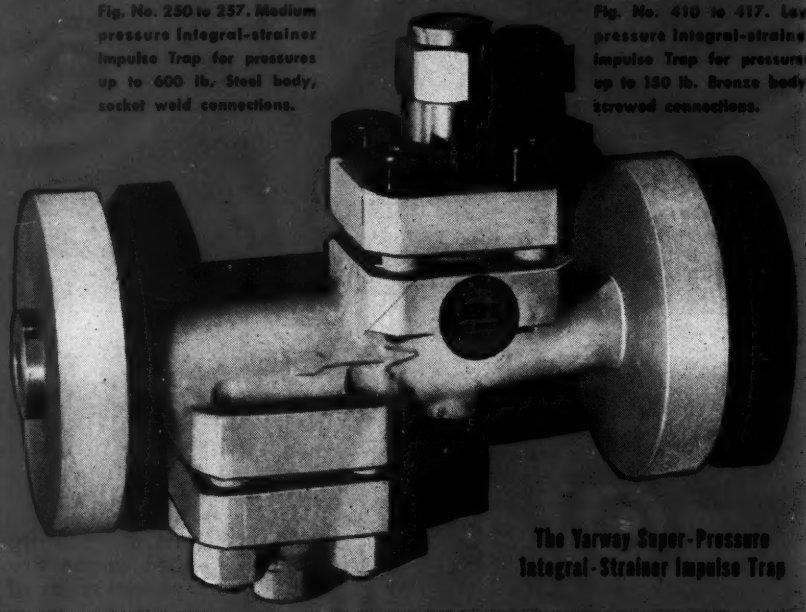
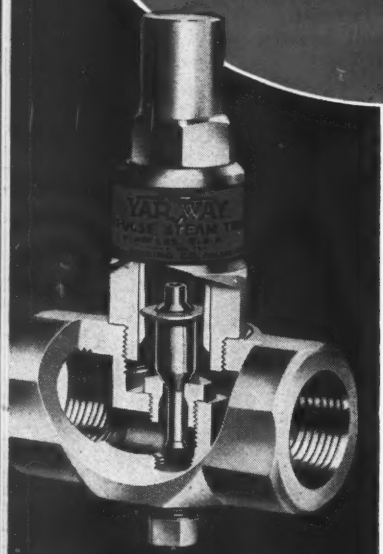


Fig. No. 150 to 157. Super-pressure Integral-strainer Impulse Trap for pressures up to 1500 lb. Steel body, flanged connections.



The Yarway Super-Pressure Integral-Strainer Impulse Trap



The Standard Yarway Impulse Trap. Note only one moving part — a little valve.

ALONG with the remarkable success of the YARWAY IMPULSE TRAP for standard trapping service (more than 250,000 have been purchased), has come its use in steam plants where pressures as high as 1500 lbs and temperatures as great as 900°F are encountered.

The integral-strainer trap shown above, developed for this service is suitable for every drainage requirement in high pressure steam installations. It has ample condensate capacity when system is being "warmed up". It will handle relatively small amounts of high temperature condensate, efficiently, without losing its prime.

The valve closes positively in the presence of dry or superheated steam.

It is a fraction of the size and weight of other type traps designed for the same service—saving space, simplifying installation and requiring no support.

It is suitable for all pressures within a wide range without change of valve or seat.

It has the same simplicity of design as does the standard Impulse Trap—only one moving part, a little valve.

Its integral-strainer protects the trap against scale and rust in the system.

For complete description of operating principle, send for Bulletin T-1738.

YARNALL-WARING COMPANY, 114 MERMAID AVE., PHILADELPHIA 18, PA.

YARWAY IMPULSE STEAM TRAP

WHAT LEADERS SAY

Production Paces The War

By CHARLES E. WILSON

IN THE FALL of 1939 Hitler's Germany struck a new note in warfare. The planning and execution of military campaigns suddenly enlarged as a gigantic contest in engineering skills. Back of the relentless panzer divisions and the screaming Stukas, there was marshaled and applied all the technical knowledge and inventiveness of a highly ingenious industrialized people. War became so mechanized that no nation could hope to survive unless it could surpass its enemies in engineering skill and inventive ability.

This puts the war squarely up to the engineers. The engineer is the strategist of the battle of production. His strategy has got to be good.

In getting into a war of this kind, we may think we are on perfectly familiar ground. Our lives have been wrapped up in machines and their uses. In peacetime we strove for high quality and mass production, but the tempo was different. In wartime, our product is tried in the test of fire. As these tests reveal that changes are needed, those changes require immediate action. The whole process of production is affected. Work goes on at white heat. Constant improvement goes hand in hand with volume production. In the long run our inventiveness and our ingenuity have got to exceed the inventiveness and ingenuity of the enemy.

That puts a terrific responsibility on us as engineers. The responsibility is primarily a demand on our skill and our technical ability, but it is also a demand for our understanding. We must realize what we are up against, what we are responsible for. The engineer has got to deliver.

Exactly what does this mean to us? I think it compels us by being very clear on three simple facts. These are:

1. The war has not been won. A good many men are going to die; billions of dollars worth of equipment is going to be destroyed before the armistice whistles start to blow.

2. Even if we were perfectly sure that the war had been won, we still would have no right to relax in our efforts to produce, because any letdown in production will surely mean unnecessary loss of life in the prolongation of the war.

3. There is a changing production pattern which we must follow, not merely to win the war, but also to insure the peace.

There is, of course, difference of opinion as to how long the war will last but before your optimism begins to run away with you, take a look at the maps. I don't mean today's encouraging maps, alone, but rather today's maps in relation to the maps of Nov. 11, 1918. The maps say that we are far from having retaken all the ground or material or natural resources which have been seized by the enemy since 1939. The maps say we have hardly done more than crack the surface of Hitler's *Festung Europe*. Our chance of breaking into that well-advertised fortress in the near future may be extremely good but the maps say we haven't done it yet. They don't tell us we are entitled to a breathing spell; rather they are a solemn warning that the hardest and costliest part of the job is still ahead of us. They show pretty clearly that Germany and Japan still hold, in territory and resources, a great deal that belongs to someone else.

Even if we insist on believing that our enemies are already beaten and will presently give up, we have no right to relax our production effort in the slightest degree. On the contrary, the very fact that victory was assured would make it more imperative for us to continue increasing our production of war goods to the very limit of our ability.

The United Nations' war effort is complex. It is made up of many parts, and all those parts have to fit together. Military strategy has to be coordinated with production schedules, with transportation timetables, with manpower assignments, etc. The failure of any part is not just a local default; it is a failure which affects and imperils the whole.

So every bit of equipment made today will save the lives of our fighting men tomorrow on some battle front. Any extra equipment made through extra effort will save extra lives. That is why we cannot tolerate any letdown in production, no matter how good the news from the front may look. Are we nearer to victory? Then, for that very reason increase the volume of production so that we may save as many boys as possible.

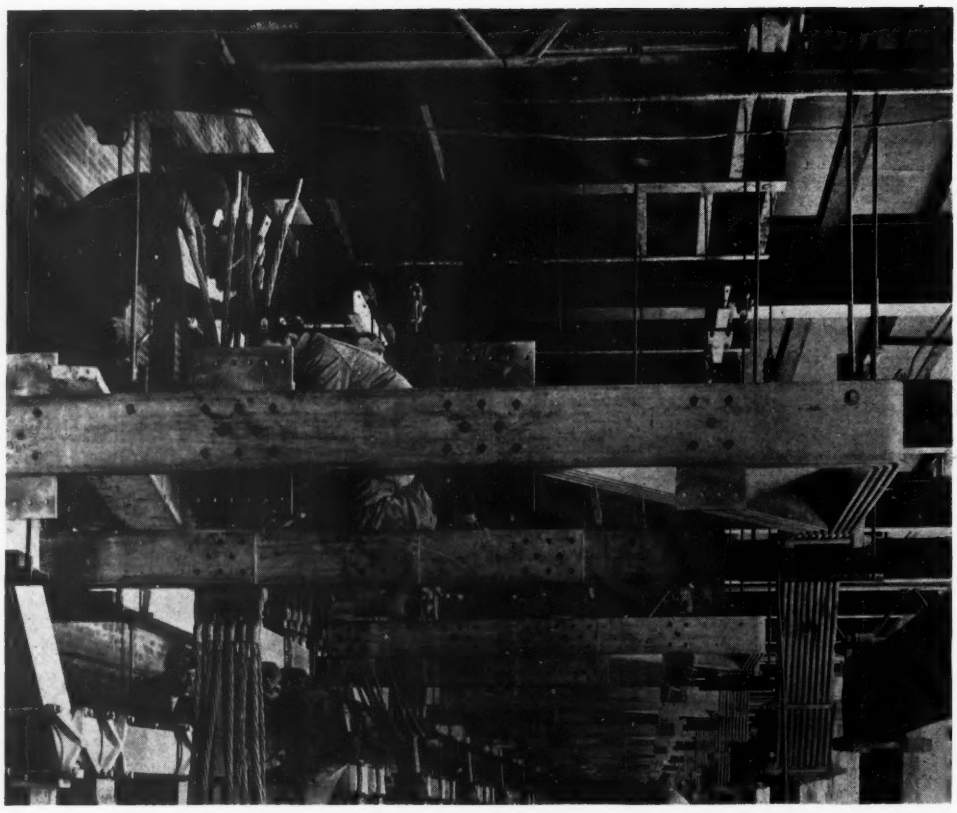
With regard to the changing pattern of production, it can be said in general that nothing stays put in this war. Mechanized war is dynamic, not static. Day before yesterday we were fighting in the blistering sands of the deserts; yesterday we were fighting on a rocky island; today we are fighting amid the mountains and plains of Italy. Tomorrow, or the day after tomorrow, perhaps our boys may be fighting in the green fields of northern Europe. And as the geography of our fighting changes, the problems of war production change accordingly.

For example: Now that we are no longer fighting in the African deserts there is a reduced demand for tank treads and air filters. The desert sands and rocks punished tanks and there was a constant and imperative demand for replacement parts. The nature of that demand has changed. Yet, as that change was made, the eternal requirement for new and better weapons brought about a different sort of demand, for instance for the bazooka and its rocket projectiles.

These two very small examples of shifting demand can be multiplied a hundredfold. They prove that we need, not only volume production but an exceedingly flexible and adaptable production system. The best we can possibly do may be good enough today, but it will never be good enough tomorrow. We are not only in competition with our enemies; we are in competition with ourselves. We must always be beating our own records.

We have to follow this rule if we are going to win the war. But that isn't the end of it. The pattern set in this war is going to carry over into the peace. That is inevitable. We have learned—at bitter cost—since this war began that no nation which tries to fight at half throttle can hope to survive. Aren't we also going to discover that it is fatal to live at half throttle in peacetime? If the peace that follows this war is to be secure, we will have to go on with the never-ending struggle to find and use techniques that will enable us to make the best possible use of what we have.

Until he became Executive Vice-chairman of the War Production Board Charles E. Wilson, was President of the General Electric Company. Born in New York City, after a meager grade school education, he went to work when he was only twelve years old as a shipping clerk with the General Electric Co. He worked his way up through the ranks until he became president of that organization on January 1, 1940. He was selected by Chairman Donald Nelson for the post of vice-chairman of the War Production Board in full charge of production, September 17, 1942. In December 1942 he was made chairman of the Production Executive Committee of WPB. On December 1 he was also made chairman of the U.S.-Canada Joint War Production Committee, succeeding James S. Knowlson. The discussion presented on this page was abstracted from an address Mr. Wilson delivered at a joint meeting of the Engineering Institute of Canada and the American Society of Mechanical Engineers at Toronto, Canada.



Better Than Copper

EXCEPT for the fact that the bus bars in this photograph are evidently intended to carry very heavy current, the picture discloses nothing very startling; it looks like a typical heavy direct-current bus system such as are found in many electrochemical plants. Actually, the installation is very unusual; few of you who look at this picture have ever seen anything like it because these massive bus bars are not made of copper but of solid silver! These bus bars carry heavy direct-current power to the magnesium cells at the new plant of the Dow Magnesium Corp. in Michigan. The photograph, taken during construction, shows how the silver bus forms a virtual canopy over the electrolytic cells. ¶ This use of silver is extremely interesting from a social standpoint. The metal was released by the government for this use to relieve the critical copper situation. Silver is even a better electrical conductor than copper having a relative conductivity of 106 compared to 100 for copper. It seems only good sense to make use of this excellent conducting material in this way rather than to store it underground, never to serve any useful purpose except to represent the wealth back of our paper money. Installed at the Dow plant in the form of bus bars it still represents the wealth back of our money. A low-grade moron should be able to figure that out but it took a war to bring it about. ¶ Down at Ft. Knox in Kentucky, most of the world's gold lies buried in elaborate and highly protected vaults. We took this gold out of the ground originally, spent millions of dollars mining, refining, rolling and transporting it, more millions in building the vaults and then we put it back into the ground again, never to serve any useful purpose whatever. Gold is not as good an electrical conductor as silver but it is very useful and it could be used for a great many purposes to help win this war but even a global war has not made us sufficiently sensible to do that. Maybe somebody can prove that the human race is not nuts.

WITH THE EDITORS

◆**CONSERVATION IN POWER PLANT OPERATION**—To follow too closely the general statements of those well meaning persons who are endeavoring to arouse the general public to the need for saving everything, particularly those materials needed for war purposes, could easily lead to serious damage to machinery necessary for the production of war goods. In the best operated power plants, engineers have set up standards to be attained. These are usually the highest efficiencies possible with the available equipment. They likewise represent the highest economies attainable. To vary even minutely from these best standards results in wastes at one or more points in the generation of power and the very act of trying to save along only one parcticular line defeats the ultimate purpose, the economical production of electric power or steam.

At the present time a nationwide drive is being made to promote conservation in all industries and homes of the country. The program has the hearty cooperation of industry as indicated by the members of committees that are working with the Government in instructing the public how to conserve without injury to men or machinery.

The term "conservation" has different meanings to different people and it should be thoroughly understood by those who use any kind of material. Too frequently "conservation" is confused with "saving." Yet neither in definition nor in the accepted use of the terms are they exactly the same. Conservation, according to dictionary definition, means a conserving, preserving, guarding, protecting, keeping in a safe or entire state. It is the opposite, or antonym, of waste. Conservation of our natural resources does not mean that they should not be used, i.e., saved in entirety for future generations, but that they may be used efficiently for a positive need of the nation. To prevent the use of material needed for the progress of the country, i.e., to save it completely, is not conservation but a miserly act which benefits no living person.

Conservation assumes use, but use at highest economy. Its meaning leans in the direction of saving, in that by conserving you accomplish the desired purpose with the least possible material, therefore, without waste. To be too saving, or penurious, in the use of necessary materials usually results in the obligatory use of other materials or more costly repairs to operating equipment. The practice of conservation is the balancing of the needs to obtain the desired results with the least expenditure of materials.

Engineers do not need to be told that needless use of materials, power and labor is wasteful. The first principle of engineering is the elimination of waste in every form. But it is not always so easy to determine at what point conservation crosses the line into the waste column. It might well be said that the best engineer is the one who can match the need with the supply and have nothing to spare. Nevertheless we all need to be reminded occasionally that developments are continuously being made to improve economy of plant operation and that the new ideas coming into the field should be given careful consideration for their possible application to specific problems which are encountered.

◆**FUEL CONSERVATION** is the oldest and yet the most important problem in the steam power plant. Numerous improvements made in the years past have increased the efficiency of combustion greatly. These improvements, however, have not been as universally employed as their merits warrant. In spite of the fact that stokers have been developed for use with the smallest size boilers, many plant owners seem satisfied with hand-fired installations having average efficiencies far below those of modern stokers. Here the saving of dollars for initial installation results in a waste of fuel which should not be tolerated.

Combustion control systems have been developed that are more than human in their response to changes in load, pressure, temperature and draft conditions with consequent improvement in fuel economy.

Directly affecting the conservation of fuel are the improvements made in boiler design which have increased the heat absorbing efficiency of the heating surfaces. Tube arrangement, baffle location, superheater location and design, employment of economizer or air preheater have all played an important part in reducing fuel requirements of the modern power plant. Furnace designs, application of insulation to boiler walls and steam piping, proper use of soot and slag removing equipment, and improved water treatment are a few of the devices used in modern power plants to effect fuel conservation.

It is noteworthy that in the Government's critical resources conservation program Dr. R. R. Sayers, Director of the Bureau of Mines, has named from private industry a National Fuel Efficiency Council consisting of twelve engineers who have made enviable reputations in the field of fuel utilization to chart and direct the fuel conservation program which is now getting nicely started.

During the present emergency many plants that depended upon oil for fuel have been required to convert to coal for the duration of the war. There can be little question that such conversions have reduced the heat absorbing efficiencies obtained in most cases. Major changes of this sort require redesigning of the furnace and resort to such experiments as overfire air. The suddenness of the emergency and the lack of necessary materials, however, forced many plants to employ hand firing of coal with efficiencies far below modern practice. It is to be hoped that the newly formed National Fuel Efficiency Council will be able to formulate plans to bring up the efficiency in these converted plants as well as in other plants that are now compelled to resort to the use of coal for which their furnace equipment was not especially designed.

Most certainly the power industry should cooperate with the Government's efforts to conserve fuel.

◆**MANPOWER SHORTAGE** presents its worries to all industrial managers but power plants have been fortunate along this line. In the better plants most of the key men are beyond the draft age; machinery has replaced manual labor to such an extent that older men of the laboring class find little difficulty in handling the work; power plant construction work has been halted, relieving men from this field of work for operating and maintenance positions; utility power plants and those serving essential industries are considered essential to the war effort and many of the workmen are given deferments. Nevertheless conservation of manpower in power plants can relieve some very fine mechanics for production work in munition factories and this should be done where such shifting of labor does not jeopardize safe and economic power plant operation.

One of the most needed phases of manpower conservation is the prevention of accidents which are reported as increasing since the start of the war. Few plants have such a fine record that they can afford to neglect safety precautions or disregard as trivial any injury, no matter how slight, that occurs while the man is on the job. Every such case should be studied and the cause determined and remedied either by disciplinary measures or the provision of safeguards. Since most injuries to persons occur when they are off the job, management would do well to look into these accidents also and give assistance to well directed safety programs conducted by the community. The National Safety Council is doing excellent work in educating the public regarding accident causes and stands ready to cooperate in all such programs.

◆**EQUIPMENT AND MATERIALS** can be conserved only as a result of specific studies. Each case represents an individual problem. New equipment to replace old may be necessary but in the majority of cases where, in peace time, replacement would be decided upon, repair or replacement of parts only will put the equipment in working order. Only careful study of the case will determine the feasibility.

Strategic materials are used in numerous places about the power plant. To replace them is difficult and in some cases impossible. Government authorities working with industrial specialists have developed many substitute materials and in the spirit of cooperative conservation these substitute materials should be used when needed in place of strategic materials.

Conservation is the essence of engineering and any program fostering true conservation should and, we are sure, will have the cooperation of men in the power plant field.

Monsanto's New Boiler Plant At Springfield, Mass.

Details of the new boiler plant built for the Plastics Division Plant of the Monsanto Chemical Co., at Springfield, Mass., to meet the increased steam requirements imposed by war-time production. Built for an operating pressure of 600 psi, at present the steam pressure carried is that which was used in the old plant, namely, 150 psi. Future plans include a turbine-generating plant and when these plans materialize, the boiler pressure will be stepped up to the full working pressure of 600 psi. The present steam generating unit has a capacity of 80,000 lb per hour

THE NEW BOILER PLANT at the Plastics Division of The Monsanto Chemical Co. at Springfield, Mass., is an excellent example of modern, industrial class, boiler plant design. Free from unnecessary frills, clean, streamlined and practical, it represents the best engineering practice in steam generation, consistent with the particular requirements of the plant at the present time.

The initial installation was originally conceived as three boilers and the boiler was designed for 700 psi instead of the 600 psi shown. This plan was not put into effect for several reasons so that the initial unit consists simply of a boiler house containing a single 100,000 lb per hr, 600 psi boiler. Although designed for a working pressure of 650 psi, at present this boiler operates at only 150 psi, in parallel with the old boiler plant. The present building can be extended, in fact much of the building steel for a future second boiler unit is in place. This future view accounts for the location of the coal handling equipment some distance away from the new boiler house.

A particular feature of the building is that the entire structural steel frame is of welded construction. As shown by the photographs, the building is simple but attractive, architecturally, being constructed of brick with an abundance of large windows set in steel sash. The building structure is surmounted by a self-supporting steel stack set directly on the structural steel of the building, above the boiler. In case of future growth, each boiler will be provided with its own stack. A cylindrical ash receiver is located immediately outside of the building into which ash is delivered by a pneumatic conveying system. This receiver is mounted on a structural steel framework built over a driveway so that trucks may drive beneath and receive the ashes from above. This equipment, of course, is located on the side of the building which will not be affected by future extensions and is of sufficient capacity to meet the requirements of the ultimate plant.

Boiler Fired by Underfeed Stokers

The boiler is fired by an underfeed stoker, supplied with forced draft by a fan driven by both motor as well as a steam turbine. Either drive can be used depending upon the heat balance requirements. The forced- and induced-

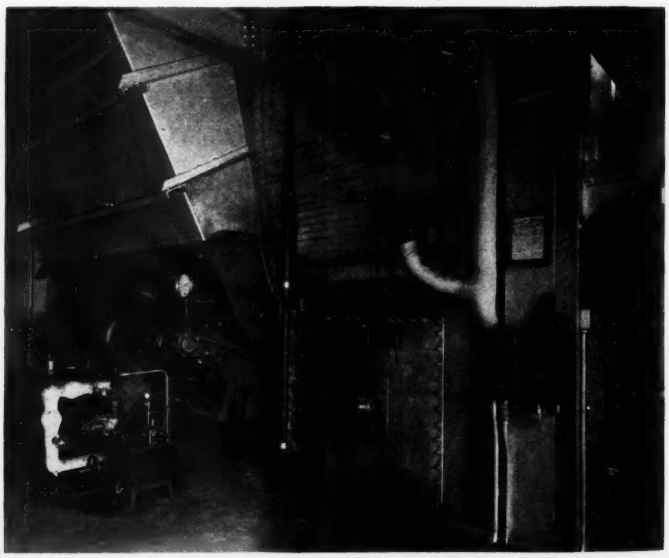


Fig. 1 (Left). An exterior view of the new boiler plant showing the ash storage and handling equipment mounted on a steel frame platform

Fig. 2 (Above). The 80,000 lb per hr boiler is fired by a seven retort, link grate, underfeed stoker, arranged for continuous ash discharge

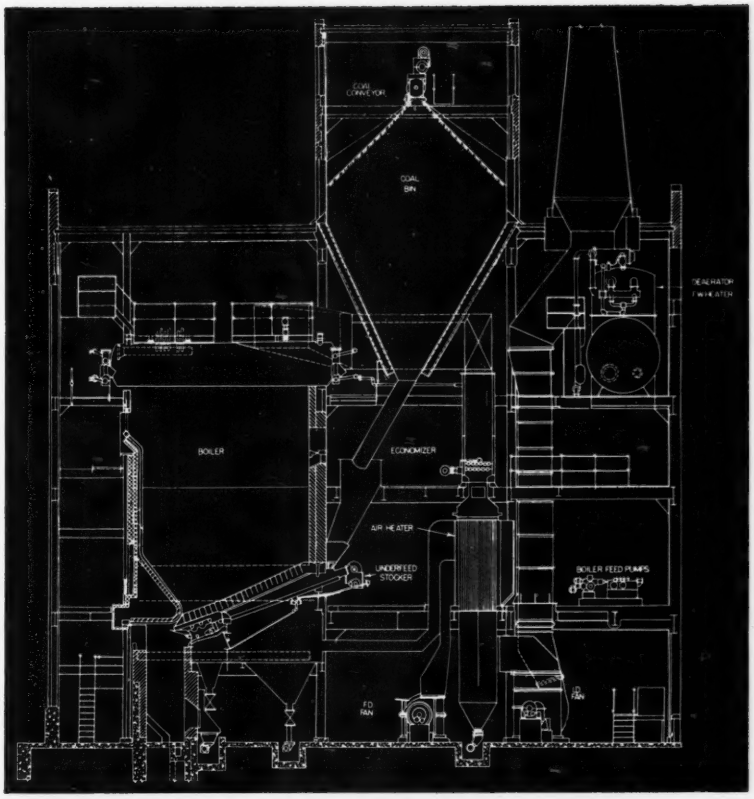


Fig. 4 (Right). Cross-section through the plant. Note the location of the air heater and the simple and direct arrangement of the forced draft ducts

draft fans are located on the ground floor instead of in the basement as indicated and the tubular type air heater and the economizer are arranged vertically, in series, above. The gas outlet is at the top of the boiler and a short length of breeching connects this outlet with the inlet to the economizer. The latter is a steel-tube economizer. Under the action of the induced draft fan, the flue gases travel down through the economizer and the air heater, respectively, and then are delivered to the stack. The entire arrangement is simple and accessible. A hopper is provided below the air heater for the collection of dust and fly ash and this hopper connects directly into the vacuum ash removal system.

Two boiler feed pumps are provided. These are located on the operating floor. These two pumps are units which were previously used in the St. Louis plant of the Monsanto Co. They are 4-stage, centrifugal units, one being driven by a G.E. turbine and the other by a Westinghouse induction motor. Either of the pumps has enough capacity to serve the boiler and either the steam or motor drive is used as heat balance requirements prove necessary.

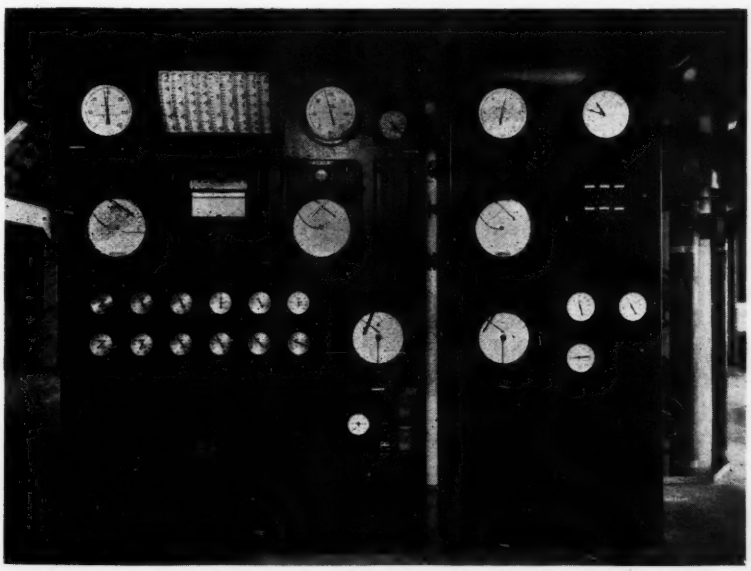


Fig. 3. The combustion control and instrument panels. Note the annunciator on the panel at the right for warning of low water levels in various tanks and receivers

Boiler Details

The boiler is a Foster Wheeler steam generating unit, designed to produce 100,000 lb of steam per hr for a period of three hours or 80,000 lb, continuously, at a pressure of 650 psi, and a total of 750 F at the superheater outlet. This unit belongs to what Foster Wheeler refers to as their S-A Class. It is a development of the well-known "A" type unit in which a steam drum at the top is connected by banks of water tubes with water drums at each side but which in the new design incorporates a single straight gas pass through the tube banks. In some cases, as in the boiler at this plant, only one water drum is provided. The superheater which is of the single pass pendant type is installed immediately behind the slag screen, the elements receiving steam directly from the steam drum. The steam drum of the unit is supported by a heavy structural frame and all tubes and water drums hang from it, being free to move with expansion and contraction. The boiler is provided with water cooled side and rear walls.

The unit contains 7979 sq ft of heating surface, not including 3240 sq ft contained in the extended surface economizer which is separate from the boiler proper. For those not familiar with the particular details of construction of this type of economizer, it may be pointed out here, briefly, that the extended surface heat absorbing elements are made by shrinking cast iron rings upon steel tubes to provide a composite construction having six times the external heat absorbing surface of the bare tubes. The rings are cast in bunches of nine and each group is accurately machined inside and at each end to assure inti-

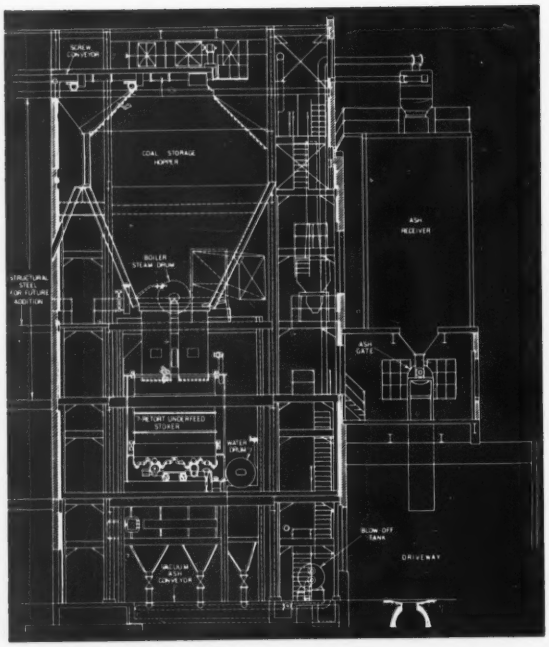


Fig. 5. Longitudinal section through the boiler plant showing the arrangement of the ash handling equipment. The ash receiver is provided with an automatic unloading gate functioning through the vacuum of the conveyor

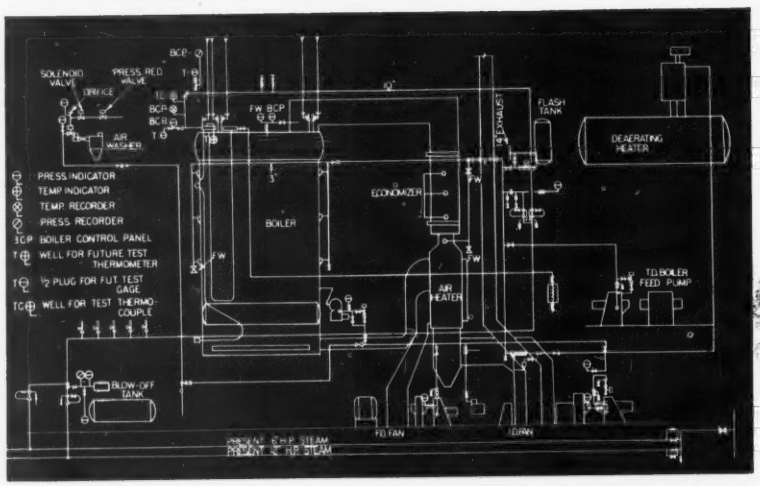


Fig. 6. A single line piping diagram of the high-pressure steam system. This system is connected with the present system in the old boiler plant by means of a 12-in. header

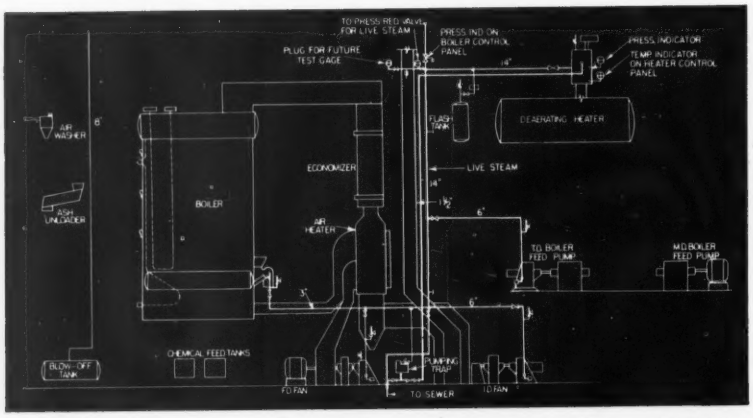


Fig. 7. A single line piping diagram of the low-pressure steam system. In case of insufficient exhaust steam a reducing valve is provided to permit the direct use of high-pressure steam

mate contact with the tube and tight male and female joints between the adjacent castings.

The air heater is of the tubular type and has a total heating surface of 2920 sq ft. It has 620 tubes, 9 ft long and arranged 31 wide and 20 deep. It is designed for counterflow operation.

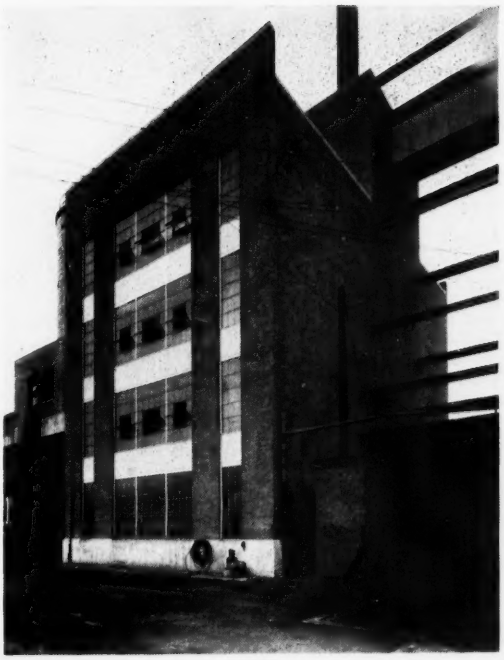
The stoker under this boiler is a Westinghouse, 7-retort link grate unit, arranged for continuous ash discharge. It is steam driven by means of a Westinghouse turbo gearbox with a disconnecting clutch and a coal feed indicator. It has a fuel supporting surface of 197.6 sq ft. The stoker is installed centrally with respect to the steam drum of the boiler and alongside of the vertical tube bank.

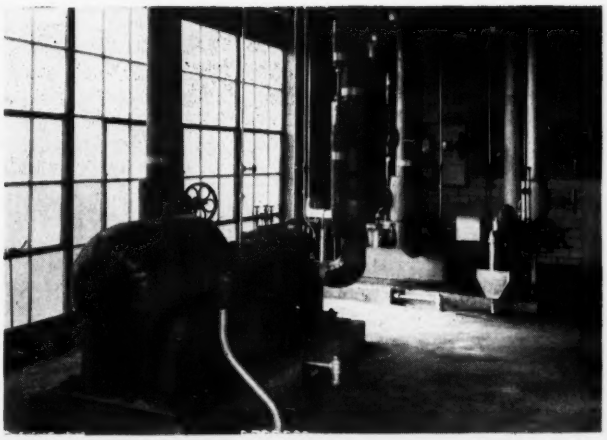
Combustion Control

Combustion is controlled by means of the Hagan system of combustion control from a central control board on the operating floor. This system as installed in this plant comprises a master sender, which is a sensitive steam pressure responsive element and which generates an air loading pressure which varies with changes in the steam header pressure; boiler and fuel relays; air flow regulator; manual control stations; and various fan, damper, and stoker speed controls. The loading pressure from the master sender is transmitted to the fuel and air flow relays and through these relays maintains a metered rate of flow across the boiler for each value of loading pressure. Each value of loading pressure from the fuel control relay causes the stoker governor to establish a definite stoker speed and therefore maintain the fuel feed in accordance with the load demand. At the same time the air flow relay functions to maintain the draft at the proper value to maintain the proper rate of combustion. It is a conventional Hagan system with no particularly special features.

The combustion control board, besides the various Hagan controls, contains a Bailey boiler meter, and a Bailey water level recorder, multi-point draft gage, Taylor recording pressure gages, a Reliance Eye-Hye water gage and a Leeds and Northrup Micromax boiler temperature recorder.

On a separate panel directly adjacent to the combustion control panel are mounted the auxiliary steam flow recorder and the recorder measuring the steam pressure of the lines to the factory as well as a water level annunciator.





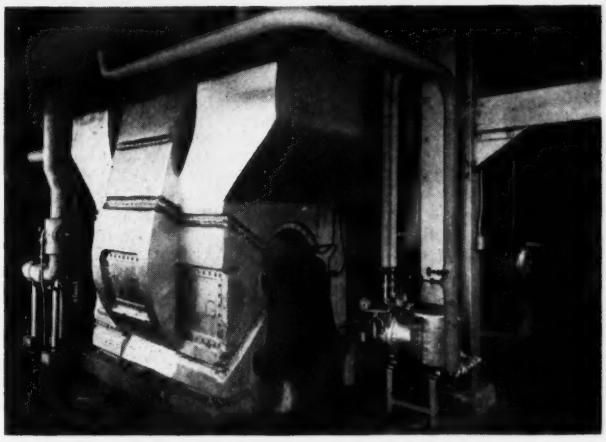


Fig. 8 (Above). Another exterior view of the plant showing how the horizontal steel members were continued through the wall of the building for future growth

Fig. 9 (Above right). The two boiler feed pumps, one steam driven and the other motor driven. These units were formerly installed in the St. Louis plant of the company

Fig. 10 (Right). A view on the ground floor of the plant showing the induced draft fan in the foreground. This fan is turbine driven

The latter operates to warn the operators of low or high water in any of six different tanks and receivers throughout the plant.

Feedwater

Water used in the boiler is city water which is treated by the Hall system of chemical treatment, using phosphate and caustic. These two chemicals are fed into the system by two small motor-driven pumps, one (supplying caustic) runs continuously while the other, through the functioning of a G.E. timing switch operates for only 5 or 6 min out of every hr.

The treated water is heated in a 250,000 lb per hr, Cochrane deaerating feedwater heater. This heater is located in the upper part of the boiler house so as to provide a positive head for the boiler feed pump suctions. It is designed for an operating pressure of 30 lb max. It is fitted with a standard parallel downflow tray bank using the sealed tray stack construction with sealed downcomers. With this construction, the entire tray bank is contained within its own internal shell and so arranged that no cold water can come in contact with any part of the external shell under pressure. The heater is fitted with Reliance, high and low water alarms as is also the flash tank. A 10-in. line from the heater supplies the common 6-in. suction header to the boiler feed pumps. On the high pressure side of the boiler feed pumps, a 4-in. line delivers water to the boiler. This 4-in. line also connects with the feedwater system in the old boiler house where other turbine driven boiler feed pumps are installed. Copes feedwater regulators control the water level in the boilers.

Coal and Oil Handling Equipment

The coal handling arrangement is simple. Coal, delivered to the plant by railroad car, is dumped into a track hopper adjacent to the area which, ultimately, will be occupied by the future extension to the plant. From this hopper, a Redler conveyor elevates the coal to a horizontal screw conveyor which delivers the coal to the overhead bunker in the boiler house. That portion of the screw conveyor as well as the Redler conveyor outside the boiler house is enclosed by a corrugated Transite housing but, of course, when the building is extended it will form an integral part of the building. The coal handling equipment was installed by the Stephens-Adamson Mfg. Co.

As already indicated, ash is handled by a pneumatic system. This is a United Nuveyor system designed to collect the ash, soot and siftings and to deliver these to the ash receiver outside the building. The receiver and multi-stage dust separator is constructed of heavy-duty Durite sections and is provided with an automatic unloading gate functioning through the vacuum of the conveyor.

Conclusion

In conclusion, a few words on the general appearance of the plant may be of interest. Perhaps the first impression that one gets is a sense of spaciousness. There is plenty of room; all equipment is installed with ample clearances, indeed there is room to spare. This, of course, makes for neatness and good maintenance.

The plant is attractively decorated, the interior walls being finished with tan glazed tile. All exposed steel is painted aluminum and all gratings and railings are painted black.

The plant was designed by

Charles T. Main, Inc., Consulting Engineers of Boston, Mass. The design and execution were carried out in collaboration with the Monsanto engineering organization. In closing we wish to express our appreciation to M. K. Bryan of Charles T. Main and to F. G. Gronemeyer, Plant Manager of the Plastics Division plant of the Monsanto Chemical Co. at Springfield, Mass., for their assistance in supplying the information used in the preparation of this article.

Principal Equipment Installed in the Boiler Plant of The Monsanto Chemical Co. at Springfield, Mass.

General

OWNER. Monsanto Chemical Co.
TYPE OF PLANT. Boiler plant
LOCATION. Springfield, Mass.
DESIGNERS. Chas. T. Main, Inc., Boston, Mass.

Boiler Equipment

STEAM GENERATOR—Foster Wheeler Corp. Class SA-54-42, 80,000 lb per hr, continuous, 100,000 lb per hr for 3 hr, designed for a working pressure of 650 psi, 750 F total temperature at superheater outlet. Heating surface, 7979 sq ft.
ECONOMIZER—Foster Wheeler Corp., extended surface type. Heating surface, 3240 sq ft.
AIR HEATER—Foster Wheeler Corp., Tubular type, designed for counter flow. Heating surface, 2920 sq ft 620 tubes, 31 wide, 20 deep. Length of tubes, 9 ft 0 in.
SOOT BLOWERS — Vulcan Soot Blower Corp. On boiler, 6 two inch LG-1. On economizer, 3 two inch LG-1. On air heater, 1 two inch pantagraph type.
FEEDWATER REGULATORS — Northern Equipment Co. Copes regulators.
STOKER—Westinghouse Electric & Mfg. Co. Seven retort, link grate underfeed stoker arranged for continuous ash discharge. Fuel supporting surface, 197.6 sq ft. Stoker drive, turbo gearbox with disconnecting clutch and coal feed indicator.

Boiler Accessories

SAFETY VALVES — Manning, Maxwell & Moore, Inc. Consolidated valves. One 1½-in., one 2-in.
FEED VALVE—Edward Valve & Mfg. Co., one 3-in., one 3-in. check.
BLOW-OFF VALVE — Edward, one 1½-in.
STEAM GAGE—Crosby, one 12-in. gage.
WATER COLUMNS—Reliance Gauge Column Co. 2 Reliance W-850, 1 mica gage glass, 1 set of three cocks.
Other small valves—Edward.

Combustion Control

COMBUSTION CONTROL SYSTEM — Hagan Corp. Comprising 1 master sender, 1 boiler relay, 1 fuel relay, 1 air flow regulator, 1 manual control station, 1 I-D fan turbine control valve, 1 uptake damper control, 1 stoker speed governor, 1 furnace draft regulator, 1 F-D fan vane control, 1 F-D fan damper control.
COMBUSTION CONTROL PANEL — Hagan, with Leeds & Northrup 'Micromax' temperature recorder, Bailey boiler meter, multi-point draft gage, water level recorder and steam flow meter; Taylor Instrument Cos. recording pressure gages and Reliance EYE-HYE water level indicator.

Fans

INDUCED DRAFT FAN—Clarage Fan Co. Type RT, No. 8, with inlet boxes on each side of housing and with radial type wheel.
INDUCED DRAFT FAN DRIVE—Westinghouse Electric & Mfg. Co., 114 hp, non-condensing, 4560 rpm, 140 psi turbine.
FORCED DRAFT FAN—Clarage, type W, Class 3, designed for 28,500 cfm at 7.10 sp.
FORECD DRAFT FAN DRIVE—Westinghouse. 1-50 hp, 1750 rpm, 150 psi turbine. 1-50 hp, 1750 rpm induction motor.

Feedwater System

BOILER FEED PUMPS—Ingersoll-Rand. 2-four stage centrifugal pumps brought from the St. Louis plant of the Monsanto Chemical Co., one driven by a General Electric turbine, one by a Westinghouse induction motor.
FEEDWATER HEATER—Cochrane Corporation. Deaerating type, capacity 250,000 lb per hr, with overall rise in vent condenser and deaerator of 60 F, min and 180 F, max, constructed for operation at 30 psi, max.
FEEDWATER TREATMENT — Hall Laboratories, Inc.

Coal and Ash Handling

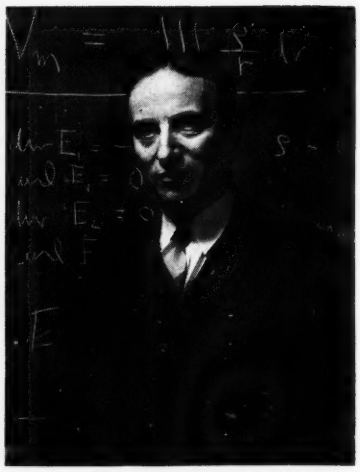
COAL HANDLING EQUIPMENT — Stephens-Adamson Mfg. Co. Redler conveyor and screw conveyor.
ASH HANDLING EQUIPMENT—United Conveyor Corporation. Nuveyor system, consisting of a receiver with multi-stage dust separator, exhauster, cyclone air washer and an 8-in. conveyor line.

Electrical Energy Is Elusive

FINDING THE PROVERBIAL needle in a haystack is easy compared to tracking down individual particles of electrical energy in complicated modern power systems according to Dr. Joseph Slepian, associate director of the Westinghouse Research Laboratories. We can measure the total amount of energy but particular bits of electrical energy cannot be traced because energy has no shape, no color, no individuality. Energy is intrinsically not observable in space and time like ordinary material objects, and cannot be identified as having come from any particular place.

The Westinghouse mathematician and physicist who developed the de-ion circuit breaker and the Ignitron at Westinghouse, states that engineers and scientists have developed a large number of different theories about the flow of electrical energy. All of these are equally valid when used properly but in recent years certain legal and administrative problems have arisen which cannot be answered correctly by any of the theories. This inability to put a tag on electrical energy presents lawyers and the courts with a puzzle that at present cannot be solved scientifically. As an example, a power company serving customers in one state buys its energy from another utility in the same state. The second company received some of the power for its system from an out-of-state source. By placing wattmeters on various lines of the two systems, engineers attempted to demonstrate that some of the out-of-state energy reached the first system through the lines of the firm selling the power. However, the data thus collected could not show this. Where there is a multiplicity of energy sources and a number of loads where the energy is being expended, it is impossible at present to determine which source is feeding energy to which load, or even to give meaning to that question. This may come as a surprise to those electrical engineers who think of a wattmeter as measuring energy flow when it actually does nothing more than measure the product of voltage and current at a particular place. Wattmeters only enable an engineer to observe changes in energy at different locations in an electrical system.

Dr. Slepian has demonstrated mathematically that all of the various assumptions about the flow of electrical energy, including the theory involving the wattmeter, give the same answers when they are used to evaluate proper unknown quantities. These are the unknown quantities that arise in the normal operation of a power system. The new unknown quantities that are giving the utility companies trouble are scientifically improper and at present they cannot be correctly evaluated.



Explains difficulty of tracking down energy —Dr. Joseph Slepian, associate director of the Westinghouse Research Laboratories, is shown with some of his mathematical calculations on electrical energy flow. He states that the various theories on energy flow are applicable when used to answer problems that arise in normal operation of a power system but fail when scientifically improper questions of legal or administrative significance are put to them.

DON'TS for the Designer of Coal and Ash Handling Installations

The first part of this article comments on a number of actual installations of coal and ash handling equipment, covering details of skip-hoists, en masse elevators, chute design and general arrangement. Suggestions are given by which the installations could have been improved to reduce costs and operating troubles. This is followed by comments on conveyor speeds and drives, shear pins and interlocks and the like and many details of belt conveyor designs. The author has been a designer and builder of materials—handling equipment for many years and speaks from the widest practical experience

By Wilbur G. Hudson, M. E.

COAL-HANDLING LAYOUTS for the medium steam plant often do not receive the attention they deserve, or are developed without asking the cooperation of the specialist. The manufacturer of material-handling equipment sometimes hesitates to make recommendations differing from the layout submitted by the purchaser's engineer because, not infrequently, such recommendations are not received with enthusiasm. Some typical layouts with features that might have been improved* are outlined in this article.

Figure 1 shows the coal and ash handling installation at a 4000 hp plant in New Jersey that has about everything as wrong as can be.

The coal storage tank is outside the boiler house and the weigh larry must travel out through a doorway in the end wall. Unless there is storage space in the tank, incoming coal must be spread in the reserve area by a gantry and grab bucket, calling for the services of a skilled operator. This reserve storage must be rehandled by grab bucket to the elevator boot-hopper.

Ash is hoed to a basement drag-chain conveyor with sprays along the inclined run. That is not a bad arrangement, but the ash is piled on the ground and must be shovelled to one side or to trucks, unless a truck stands ready to receive a load. Piled wet ash exposed to freezing presents a difficult problem.

*These criticisms are not intended to be captious. Several of the installations commented on were the author's own mistakes.

Skip-Hoist Layouts

Coal and ash handling equipment at a 5000-hp plant in northern New York is shown in Fig. 2. Both coal and ash are handled by a single skip-hoist, which has automatic control when handling coal and semi-automatic control when handling ash. Note the height to which the head frame of the skip must be carried to provide for a 45-deg chute to the ash bin. If the coal storage tank were larger and partitioned off so that one-third of its capacity serves as an ash bin and two-thirds as a coal bin, the costly head frame and long chute could be eliminated.

Figure 3 shows a layout with automatic skip hoist which receives coal from a track hopper and discharges through twin chutes to the overhead bunker, or through a long chute to reserve storage. This layout assures considerable of a dust nuisance, both when filling the bunker and when stocking out.

A better arrangement would be a slow-speed elevator, discharging to a distributing screw mounted on a dust-tight covered bunker. Reserve storage might then be by a horizontal conveyor extending across the tracks to a point farther removed from the plant, whence it could be reclaimed by a small bulldozer. Chuting coal through an extremely long chute should be avoided when possible.

Returning to the disposal of ash, Fig. 4 is interesting. The left-hand view was taken while dry ash was being handled by a centrifugal discharge elevator from the basement to a car. The right hand

Fig. 1. Coal and ash handling installation for a 4000 Bhp plant, showing large amount of extra handling required, especially for ash

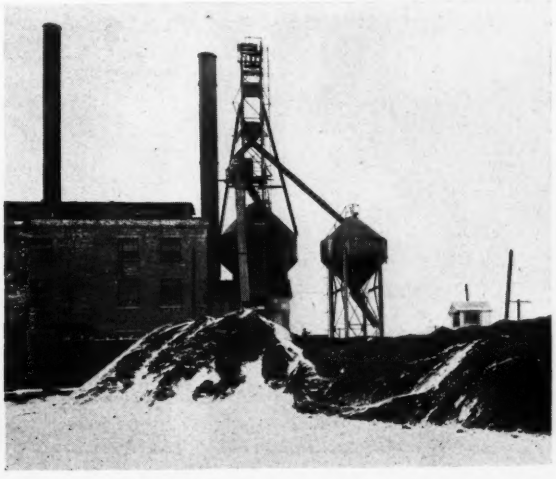


Fig. 2. Skip-hoist loads both coal and ash tanks; these could be combined, says author, to reduce head frame height

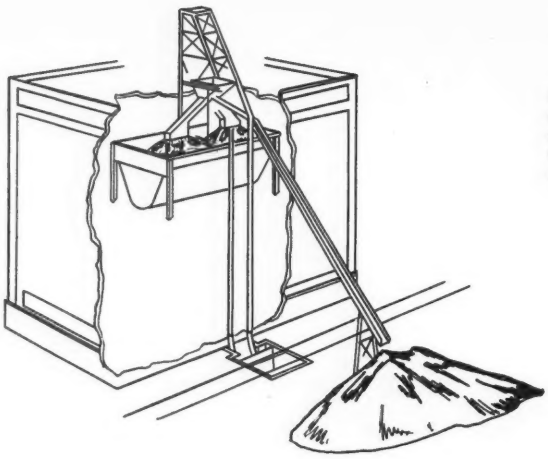


Fig. 3. In this layout, elevator, screw conveyor over bunker and conveyor to reserve storage are recommended to reduce dust nuisance

view shows damp ash, automatically quenched in transit through a pneumatic system, discharging to a car. Quite an improvement in operating conditions, both out-of-doors and in the basement!

En-masse Elevator Layouts

The en-masse elevator now provides a simple layout for handling boiler-house coal, but it should be recognized that each bend or articulation of the chain under load decreases the chain life, and the chain is the costly part of an en-masse conveyor.

In Fig. 5, left, an elevator of this type is shown with a sharp bend in the path to bring the discharge above the center of the storage tank. The element passes over an idler wheel, and dribble at this point is chuted to the tank. The arrangement at the right would be better. The tank top is flat, providing a convenient platform for repairs and servicing, and the maintenance cost will be substantially less.

Chute Design

Too often the draftsman deems it necessary to lead a chute to the center of a tank or silo, as in Fig. 6, left. Actually the peak of a pile formed by a 45-deg chute is not directly under the end of the chute, but well beyond that point, as shown at the right. Recognition of this will save in height of elevator and cost of head supports. Coal will flow in a chute pitched at 35-deg when dry, but a slope of close to 45-deg is necessary to prevent jamming when coal is damp or chilled.

Keeping Investment Costs Down

Considerable reduction in investment sometimes may be made through careful study. In Fig. 7 the upper view A shows a conventional arrangement of feeder, flight conveyor to a crusher with by-pass, and a gravity-discharge elevator of 80-ft vertical lift and 100-ft horizontal run — handling capacity 75 tons per hour.

The estimated cost of this layout was $24,000. It called for an outside crusher pit and crusher house, and heavy supports for the top or drive group of the elevator not included in the above figure.

The lower view shows the accepted alternate arrangement, costing $18,000. It has the same layout from the track hopper to the crusher, which is now located on the basement floor inside the building. Here a 17-in. Redler loop-type elevator at 50 ft per min extends to an overhead single-strand suspended flight conveyor.

Conveyor Speed

The element of proper speed sometimes is not given attention. While too high a speed—partial loading—may not have much effect on a screw conveyor, flight conveyor or bucket elevator, it does

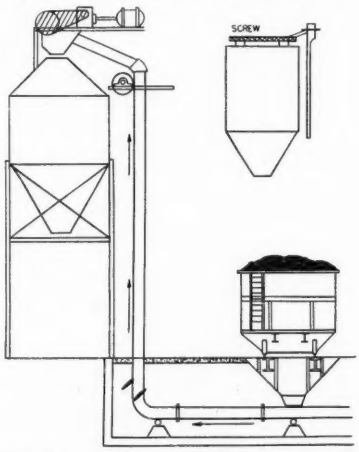


Fig. 5. At left, en masse elevator with sharp bend at top. At right, how flat top tank and screw conveyor would eliminate bend, reduce maintenance

substantially reduce the total tonnage which will be carried by a conveyor belt. There is little excuse for partial loading, because the usual roller-chain drive between head shaft and reducer shaft permits a change in speed at small cost. Running a conveyor faster than necessary wastes power and boosts maintenance cost per ton handled.

Reciprocating Feeders

We often see a reciprocating feeder with the reciprocating plate placed horizontal instead of on an incline. A plate reciprocating horizontally ceases to feed when the car above the track hopper is emptied. Then the coal merely pumps up and down. If the plate is inclined 10 or 15 deg, however, the feeder is practically self-clearing.

The reciprocating feeder has the dignified antiquity of the side-wheel steamboat. The modern electro - magnetic feeder (Syntron,

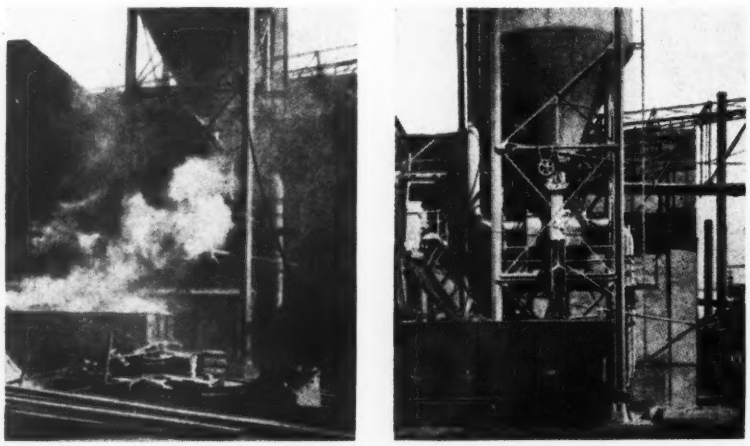


Fig. 4. Left—View of ash-handling installation discharging dry ash from basement to a car. Right—Same installation, remodeled with pneumatic system, discharging wet ash, showing elimination of dust

Traylor, Utah, etc.) has no "moving" parts, is easily adjusted, while running, for changes in rate of feed, and has far less cost of upkeep.

Shear Pins and Interlocks

Nearly all flight conveyors, en-masse conveyors, bucket elevators, etc., are protected against overloads

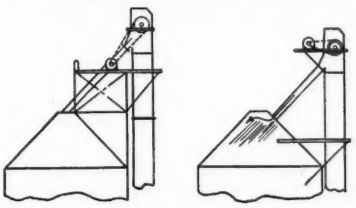


Fig. 6. Left—Chute led to center of tank. Right—How knowledge that peak of pile is not under end of chute can reduce elevator height and head supports

or jamming by a shear pin in the drive. But one point often overlooked is that it is useless to interlock electrically the motors driving tandem units, for if the pin of the second unit shears, that motor continues to spin, and the first unit continues to pour coal into the stalled unit. It is a simple detail to electrically interlock the farther shear pin with both motors, so that both units will stop at once if the pin shears.

Belt Conveyor Loading and Drive

The inclined belt conveyor is the favored machine for the large capacities required in the great steam plants. In no other type of conveyor is consultation with the specialist so important, since errors in design or layout may result in needlessly high first cost and continuing high cost of maintenance. Two important points are the method of loading and the arrangement of the drive.

Observe the flow of coal to such a conveyor when in operation. If there is a sharp impact where the coal lands on the belt, there is a continuous churning and abrasion. This is reduced if the material is chuted in the direction of belt movement and fine coal is sifted through the chute to form a cushion on which the lumps then land. Rubber-covered or pneumatic-tired idlers at the loading point substantially increase the life of the belt. If the troughing idlers are not very closely spaced at the point where the load strikes the belt, lumps will work under the skirtboards and will be crushed between skirts and belt.

The required horsepower may call for a dual drive to secure the required effective tension. The dual drive involves skillful engineering. Tandem geared pulleys are objectionable because the second pulley is in contact with the dirty side of the belt and may become plastered with coal dirt, which, in effect, increases its diameter. Then this pulley hogs the load, sometimes shattering the driving gear.

The dual motor drive, if properly designed, adjusts itself to the load distribution, and may reduce the number of plies and cost of belt by reducing the maximum belt tension.

The use of fixed side-guide idlers is bad engineering because eventually they damage the edges of the belt. Self-aligning idlers steer the belt to a central position, but it is wrong to assume that this is their ultimate function. They merely indicate that idlers, head pulleys or foot pulleys are out of line and are calling for adjustment.

Belt Speed and Interlocking

Occasionally we see a layout for a plant where extension or enlargement has been taken into consideration and where the initial coal handling capacity will eventually be increased. So the designer may specify, say, 36-in. idlers, head pulleys and foot pulleys, but with a 30-in. belt. As a rule, it is better to specify the belt as 36-in. also, with the initial speed lowered to get the initial capacity. As the capacity requirements increase, the belt speed can be increased. This assures low maintenance costs and long service.

Unfortunately the belt conveyor cannot be protected against damaging overloads by a shear pin as effectually as can a flight conveyor, since some of the accidents which damage the belt are accompanied by only slight overloads—for example, a fragment of steel lodged in the loading or discharge chute. However, the belt conveyor should be interlocked with the unit that feeds to it in such a way that the feeder will stop automatically if the belt stops and can be started only after the belt is up to speed.

It is desirable to fix the inclination of the belt at somewhat less than the 18 deg maximum. While coal will travel on a belt inclined at 20 deg, or even somewhat more, there is a "bump" at each idler that causes a backward slip of the material, a circumstance which does not contribute to belt life. This slip is imperceptible but is recognized by the manufacturer by rating the capacities as 10 per cent less for inclined belts.

Belt Cleaners

Another detail of importance, if the coal may be damp and sticky, is the belt cleaner. If the belt surface is not thoroughly cleaned, the return idlers and snub pulleys become crown-faced and it is impossible to maintain the belt central. The routine cleaner is a high-speed, rotary, bassine-fibre brush, which wears rapidly and may become clogged with dirt and with embedded, sharp, metallic fragments. Better cleaners for belts handling coal are now available. One of the most effective is a short-center scraper-flight unit driven from the head shaft or counter shaft at slow speed (25-ft per min), either in the direction of the belt movement or the reverse direction. This cannot injure the belt and it cleans the surface to a degree limited only by the number of rubber-edged flights employed.

The prospective purchaser will avoid considerable trouble and expense if the recommendations of the manufacturer are solicited when any type of material-handling equipment is to be installed. If the material is one difficult to handle—for example: oil-sprayed coal on rubber-covered conveyor belts; actively corrosive wet coal; material at a temperature higher than 450 F; metallic powders, especially pulverized zinc; extremely abrasive aluminum oxide; fragile carbon black pellets; or sewage sludge—it is probable the manufacturer has learned through severe losses what type of machine is best suited to handle it, hence it will be unnecessary for the purchaser to undertake any pioneering.

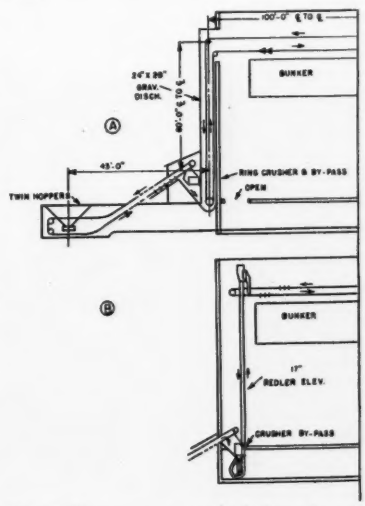


Fig. 7. How a proposed design A was redesigned to give arrangement B, saving 25 per cent of investment cost

How To Select, Install, and

Much has been written on the selection and care of electrical motors and most engineers know something about various aspects of the subject. There are many important little things about the care of motors that even those who operate them do not always think about and it is largely as a reminder to those men that we present this article by Mr. Vea. It deals with various aspects of motor maintenance, selection and installation

By O. F. VEA
Motor Division
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WARTIME CONDITIONS make it necessary that all electric motors be babied. Maintenance programs must be intensified to prevent breakdowns and every possible effort should be made to keep the motors turning because new ones are hard to get.

Maintenance really begins with selection. Motors must be chosen that are properly rated and protected for their work. The selection involves a study of requirements, whether for continuous or intermittent duty, speed, regulation, torque, starting duty, etc., all of which have a bearing on just what type of motor to choose. The characteristics and applications of standard a-c and d-c motors are shown on a chart on p 120 of this issue. In addition, the environment in which the motor is to operate should be considered, since this determines whether an open motor or some form of enclosed motor should be used, and how the motor should be located with respect to the driven load.

The next point to be considered is installation. The most important items from the standpoint of long, trouble-free life for a motor follow. The motor should be located in such a way that it is accessible for inspection and repairs and that it has ample ventilation. A standard motor should not be installed where the ambient temperature or normal temperature rise is more than 40 C.

Connecting the Motor

All electrical connections to a motor should be made tightly enough so that the vibration of the equipment will not loosen them. Wires joined in a conduit box should be either twisted together and soldered, or bolted together. These joints should be wrapped first with rubber tape, and then with friction tape.

Wires issuing from a conduit box, especially rubber-covered extension cords, should be held in some way so that there is no strain on the connections themselves. Usually a knot in the wire inside the conduit box, or the use of conduit-box fittings that grip the wire where it leaves the box, are the most convenient ways to obtain this strain relief.

A little extra care when starting the motor for the first time is a good precaution. For example, trouble may be avoided by a look at the brushes of a direct-current or single-phase repulsion motor to make sure that they are seating properly on the commutator, and with the proper pressure. It is always good practice to turn the motor over by hand before applying power to be sure that it turns freely, and that no foreign materials or objects have fallen into the motor during shipment or handling.

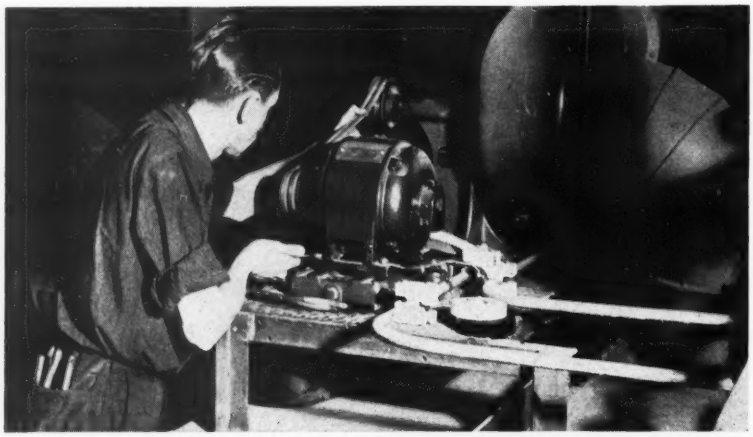

Fig. 1. Install the motor in such a way that it is accessible for inspection and repairs. Care should be taken to align the motor properly with the driven load

Inspection

Frequency of inspection and degree of thoroughness vary, and will have to be determined by the maintenance engineer. They will be governed by (1) the importance of the motors in the production scheme (that is, if the motor fails, will the whole works be shut down?), (2) percentage of time the motor operates, (3) nature of service, (4) environment.

An inspection schedule must, therefore, be elastic and adapted to the needs of each plant. The following schedule, covering both a-c and d-c motors, is based on average conditions insofar as duty and dirt are concerned:

EVERY WEEK

1. Examine commutator and brushes
2. Check oil level in bearings
3. See that oil rings turn with shaft
4. See that shaft is free of oil and grease from bearings
5. Examine starter, switch, fuses, and other controls
6. Start motor and see that it is brought up to speed in normal time.

EVERY SIX MONTHS

1. Clean motor thoroughly, blowing out dirt from windings and wipe commutator and brushes
2. Inspect commutator clamping ring
3. Check brushes and renew any that are more than half worn
4. Examine brush holders and clean them if dirty. Make sure that brushes ride free in the holders
5. Check brush pressure
6. Check brush position
7. Drain, wash out, and renew oil in sleeve bearings
8. Check grease in ball or roller bearings
9. Check operating speed or speeds

Maintain Electric Motors

Fig. 2. Check motor foot bolts and end-shield bolts every 6 months to make sure they are securely fastened. Here is a good example of how not to do this—use a wrench, not pliers

10. See that end play of shaft is normal
11. Inspect and tighten connections on motor and control
12. Check current input and compare with normal
13. Run motor and examine drive critically for smooth running, absence of vibration, worn gears, chains, or belts
14. Check motor foot bolts, end-shield bolts, pulley, coupling, gear and journal setscrews, and keys
15. See that all motor covers, belt and gear guards are in good order, in place, and securely fastened.

ONCE A YEAR

1. Clean out and renew grease in ball or roller bearing housings
2. Test insulation by megger
3. Check air gap
4. Clean out magnetic dirt that may be hanging on poles
5. Check clearance between shaft and journal boxes of sleeve-bearing motors, to prevent operation with worn bearings
6. Clean out undercut slots in commutator
7. Examine connections of commutator and armature coils
8. Inspect armature bands.

The competent maintenance man will have a record card for every motor in the plant. All repair work, with its cost, and every inspection can be entered on the record.

Lubrication

One of the major features of a maintenance program, from the standpoint of effect upon the general performance of a motor, is proper lubrication.

The point has now been reached where the bearings of modern motors, whether sleeve, ball or roller, require only very infrequent attention. However, oiling and greasing of new motors is quite often entrusted to careless attendants who apply oil or grease copiously and frequently to the outside as well as the inside of bearing housings. Some of the excess lubricant is carried into the machine and lodges on the windings, where it catches dirt and thereby hastens ultimate failure. If the proper amount of a suitable lubricant is applied before starting, there should be no need to refill the housings for several months, even in dusty places.

GREASING BALL-BEARING MOTORS

Only a high grade of grease, having the following general characteristics, should be used for ball-bearing lubrication:

1. Consistency a little stiffer than that of Vaseline, maintained over the operating-temperature range
2. Melting point preferably over 150 C
3. Freedom from separation of oil and soap under operating and storage conditions
4. Freedom from abrasive matter, acid, and alkali.

In greasing a motor, care must be taken not to add too large a quantity of grease or it will cause too high an operating temperature with resulting expansion and leaking of the grease, especially with large bearings operated at slow speeds.

The following procedure is recommended for greasing ball-bearing motors equipped with a pressure-relief greasing system:

Make sure that no dirt gets into the bearing with the grease by wiping clean the pressure-gun fitting, bearing housing, and relief plug. Always remove the relief plug from the bottom of the bearing before using the grease gun.

With a clean screw driver or similar tool, free the relief hole of any hardened grease, so that any excess grease will run freely from the bearing. With the motor running, add grease with a hand-operated pressure gun, until it begins to flow from the relief hole. This tends to purge the housing of old grease. If it might prove dangerous to lubricate the motor while it is running, follow the procedure with the motor at a standstill.

Allow the motor to run long enough after adding grease to permit the rotating parts of the bearing to expel all excess grease from the housing. This very important step prevents over-greasing the bearing. Finally, stop the motor and replace the relief plug tightly with a wrench.

GREASING BALL-BEARING MOTORS NOT EQUIPPED WITH A PRESSURE-RELIEF SYSTEM

Under average operating conditions, the grease with which the bearing housings of motors not equipped with pressure-relief sys-

Fig. 3 (Left). Keep motors free from dust and dirt by frequent wiping. This motor is arranged so that the nameplate can be quickly and easily read

Fig. 4 (Below). Check the oil level in sleeve bearings frequently. This is especially important today because of the scarcity of bearing metal

tems, were packed before leaving the factory is sufficient to last approximately one year. When the first year of service has elapsed, and once a year thereafter (or oftener if conditions warrant) the old grease should be removed and the bearings supplied with new grease.

To do this, disassemble the bearing housings and clean the inside of the housings and housing plates—or caps—and the bearings, with carbon tetrachloride. When thoroughly cleansed of old grease, reassemble all parts except the outer caps, or plates.

Apply new grease, either by hand or from a tube, over and between the balls. The amount of grease to be used varies with the type and frame size of the particular motor. The instruction sheet which accompanied the motor should be consulted for this information.

The technique for greasing motors equipped with roller bearings is very similar to that used for ball bearings.

OILING SLEEVE BEARINGS

The oil level in sleeve-bearing housings should be checked periodically with the motor stopped. If the motor is equipped with an oil-filler gage, the gage should be approximately three-quarters full at all times.

If the oil is dirty, drain it off by removing the drain plug, which is usually located in the bottom or side of the bearing housing. Then flush the bearing with clean oil until the outcoming oil is clean.

In fractional-horsepower motors, there may be no means of checking oil level, as all the oil may be held in the waste packing. In such cases, a good general rule for normal motor service is to add 30 to 70 drops of oil at the end of the first year and to re-oil at the end of each subsequent 1000 hr of motor operation. Most fractional-horsepower motors built today require lubrication about once a year. Small fan and agitator motors will often require more frequent lubrication, with three-month intervals between oilings.

Sleeve-bearing housings are provided with liberal settling chambers into which dust, dirt, and oil sludge collect. The only cleaning necessary is to remove the drain plug and drain the oil, which will flush out most of the settled material with it.

Cleaning Ball Bearings

The pressure-relief method of greasing motors, described above, tends to purge the bearing housing of used grease. Complete cleaning of bearings, therefore, is required at infrequent intervals only. For a thorough and convenient flushing when the bearings are not disassembled, the following method is recommended:

Wipe clean the housing, pres-

sure-gun, and relief fittings, and then remove both fittings. A bit of abrasive once in a bearing may not be removed even with the most thorough cleaning. Afterwards, it may become dislodged and get between the bearing surfaces with serious results.

With a clean screw driver or a similar tool, free the pressure-fitting hole in the top of the bearing housing of hardened grease. Also, free the relief-plug hole in the bottom of the housing from old grease to permit easy expulsion of the old grease during the cleaning process after the solvent is added.

Fill a syringe with grease solvent, such as carbon tetrachloride, and inject some of it into the bearing housing through the pressure-fitting hole, while the motor is running. As the grease becomes thinned by the solvent, it will drain out through the relief hole. Continue to add solvent until it drains out quite clear.

Replace the relief plug and inject solvent until it can be seen splashing in the filling hole. Allow the solvent to churn for a few minutes, and then remove the relief plug and drain off the solvent. Repeat the churning operation until the solvent runs clean.

When using carbon tetrachloride for flushing, replace the relief plug and inject a small amount of light lubricating oil. Allow it to churn for a minute or two before draining off. This will flush out the solvent. To complete the job, grease the bearing, using the method previously described.

Care of Insulation

Care of insulation goes hand in hand with lubrication as one of the major features of a motor maintenance program. These features concern the most vital, and probably the most vulnerable, parts of a motor.

Motors should always be stored in a dry, clean place until ready for installation. Heat should be supplied to protect against alternate freezing and thawing.

Current at a low voltage can be passed through the windings, electric heaters can be used, or even steam pipes can be utilized for protective purposes. In the case of extended idle periods, tarpaulins may be stretched over the motor and a small heater put inside to maintain the proper temperature.

Drying Out

The most effective method of drying out motors that have become wet by accident or because of "sweating" is to pass current through the windings, using a voltage low enough to be safe for the winding in its moist condition.

Thermometers should be placed on the windings to see that they are heated uniformly. Temperatures should not exceed 90 C (Class A insulation). This method is particularly effective on high-voltage motors, where the insulation is comparatively thick.

Heat can be supplied externally by placing heating units around the machine, covering with canvas, and leaving a vent at the top to permit moisture to escape. In doing this, it is essential that there be a circulation of warm air over all the surfaces to be dried. The air should be allowed to escape as soon as it has absorbed moisture.

Twelve-inch fans set to blow air across the fronts of "glow heaters" and then into the lower part of a motor from opposite sides will produce excellent results. The temperature of the winding should not be allowed to exceed 100 C for Class A insulated motors. Smaller machines can be placed in ovens, the same temperature limits being observed.

Insulation Resistance Tests

The time required for complete drying-out depends considerably on the size and voltage of the motor. Insulation resistance measurements should be taken at intervals of 4 or 5 hr until a fairly constant value is reached. These tests are a good indication of the general condition of the insulation and its ability to stand the operating voltage.

The resistance should at least equal the recommended AIEE standard, which is:

$$\text{Megohms} = \frac{\text{Rated voltage of the machine}}{\frac{\text{Rating in kva}}{100} + 1000}$$

Insulation resistance tests should also be made before a high-potential test, to determine whether the insulation is ready for such a test, and afterwards to make certain that the high-potential has not injured the insulation.

High-Potential Tests

High-potential tests should be made after drying out or after repairs to check the dielectric strength of the insulation.

New windings should successfully stand a high-potential test of twice normal voltage plus 1000. Motors that have been in operation for some time should be tested with this method, *after thorough cleaning and drying,* using a voltage of about 150 per cent of normal voltage, applied for one minute.

Small high-potential testing sets are available for such work and are of such capacity that very little damage will result from a breakdown during the test.

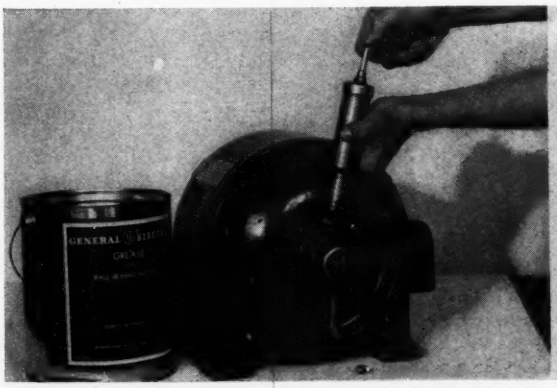

Fig. 5. For the convenience of the maintenance man, many motors have bearings arranged to be greased with a pressure gun. Here is a standard ball-bearing open motor being greased after hardened grease has been removed

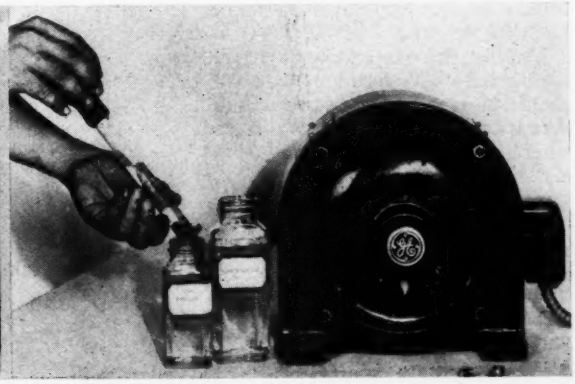

Fig. 6. Thorough cleaning of ball-bearing housings at periodic intervals is beneficial in obtaining long bearing life. The housing of this motor can be flushed out without disassembling the motor

Cleaning Motors

A systematic and periodic cleaning of motors is necessary to insure best operation. While some machines are installed where dust, dirt, and moisture are not present, most motors are located where some sort of dirt accumulates in the windings. If conditions are severe, open motors might require a certain amount of cleaning each day. For less severe conditions, weekly inspection and partial cleaning are desirable.

For the weekly cleaning, the motor should be blown out with dry, compressed air (about 25 to 30 lb psi). Where conducting and abrasive dusts are present, even lower pressure may be necessary, and suction is to be preferred, as damage can easily be caused by blowing the dust and metal chips into the insulation. On larger d-c machines, the air ducts should be blown out so that the ventilating air can pass through as intended.

In cleaning a motor, the heavy dirt and grease should first be removed with a heavy, stiff brush, wooden or fiber scrapers, and cloths. Rifle-cleaning brushes can be used in the air ducts. Dry dust and dirt may be blown off, using dry compressed air at moderate pressure. Care must be taken to direct the air so that dust will not be pocketed in the various corners.

Grease, oil, and sticky dirt are easily removed by applying cleaning liquids like carbon tetrachloride, gasoline, or naphtha. There are several good methods of applying the cleansing liquid.

While the insulation will dry quickly at ordinary room temperature after cleaning, it is highly desirable to heat it to drive off all moisture before applying varnish. If the motor can be spared from service long enough, the insulation should be dried out by heating to from 90 to 100 C.

While the motor is warm, a high-grade insulating varnish should be applied. For severe acid, alkali, or moisture conditions where oil or dusts are present, special varnishes can be supplied.

The varnish may be sprayed or brushed on. For small stators or rotors, it is best to dip the windings into the varnish, cleaning off the adjacent metal parts afterwards by using a solvent of the varnish. After applying the varnish, the best results are obtained by baking for a length of time recommended by the varnish manufacturer, which often is from 3 to 7 hr at about 100 C.

If the machine must be put back in service quickly, or if facilities are not available for baking, fairly good results will be obtained by applying one of the quick-drying black or clear varnishes which dry in a few hours at ordinary room temperatures.

General Overhauling

Motors should generally be given an overhauling at intervals of five years or so, normally, or, if the service is more severe, more frequently. Such a practice is beneficial in avoiding breakdowns and in extending the useful life of the equipment. Where periodic overhauling is practiced, the following notes may be helpful.

Check the motor air gap, between stator and rotor, with feelers for uniformity. Small clearance at the bottom may indicate worn bearings.

Take the motor apart and inspect it thoroughly. Measurement of the bearings and journals may indicate need for new bearing linings. Remove the waste from waste-packed bearings and rearrange or replace it, so that any glaze on the wool is removed from its point of contact with the shaft. Any gummy deposit means that the wool should be replaced. All lubricant should be cleaned out of the bearings and a fresh supply put in when the motor is reassembled.

The rotors and stators should be cleaned with a solvent to remove any accumulated dirt, after which any rust should be removed with fine sandpaper (not emery paper). When clean and dry, the rotors should be coated with a good grade of clear varnish or lacquer to protect them from moisture. To prevent injury to the bearings, they should be completely protected with a clean rag when the motor is disassembled.

The rotors of wound-rotor motors should be given the same treatment as the stators. In addition, soldered joints and binding cords should be inspected and any weakness remedied.

Additional Care for D-C Motors

To insure efficient operation of d-c motors, the following inspection and servicing should be done systematically.

Brush Inspection

The first essential for satisfactory operation of brushes is free movement of the brushes in their holders. Uniform brush pressure is necessary to assure equal current distribution. Adjustment of brush holders should be set so that the face of the holder is approximately $\frac{1}{8}$ in. up from the commutator; any distance greater than this will cause brushes to wedge, resulting in chattering and excessive sparking.

Check the brushes to make sure that they will not wear down too far before the next inspection. Keep an extra set of brushes available, so that replacement can be made when needed. Sand in new brushes, and run the motor without load as long as possible. Check the freedom of motion of each brush in the brush holder.

When replacing a brush, be sure to put it in the same brush holder and in its original position.

When installing new brushes, fit them carefully to the commutator. To do this, insert a strip of fine sandpaper, sand side up, between the commutator and the brush. Rotate the commutator back and forth, allowing the brushes to bear on the sandpaper only when the commutator is moving in the proper direction of rotation. Be sure that brush shunts (pigtails) are fastened securely so that current will not overheat the brushes and brush holders.

Check the springs that hold the brushes against the commutator. Improper spring pressure may lead to commutator wear and excessive sparking. Excessive heating may have annealed the springs, in which case they should be replaced and the cause of heating corrected. Larger motors have means for adjusting the spring pressure, which should be 2 to $2\frac{1}{2}$ psi of area of brush contact.

Commutator

Inspect the commutator for color and condition. It should be clean, smooth, and a polished-brown color where the brushes ride on it. A bluish color indicates overheating of the commutator.

Roughness of the commutator should be removed by sandpapering or stoning. Never use emery cloth or an emery stone. For this operation, run the motor without load. If sandpaper is used, wrap it partly around a wood block.

Never put oil on the commutator. Proper selection of brushes gives the commutator all the lubrication required to prevent excessive wear and to build up a good smooth operating glazed surface on the copper. The addition of oil results in the development of a high resistance film which may cause undue heating and rough brush action. The oil will also have a detrimental effect on the internal parts of the commutator.

Turbine Blade Deposits, Prevention and Removal

By RALPH E. TURNER

Editor,

Power Plant Engineering

Progress is being made by water chemists to remove cause of turbine blade deposits but complete answer is not yet available. Effects of deposits on the operation of turbines and methods of detection of presence of deposits are outlined in this article, and specific directions are given for removal by methods in common use by turbine engineers

ANY PIECE of equipment that runs at as high a speed as does a steam turbine must be designed and built with precision accuracy. Similar precision must be maintained while the turbine is in operation for any change from the conditions for which the turbine was designed is bound to affect some phase of operation. One of the most common of the changes which take place during operation of a steam turbine is the accumulation of deposits on the blades.

The materials of which these deposits are formed are carried by the steam into the turbine passages from the boiler. This accumulation retards the flow of steam, changes the effective shape of the blade surface, causes changes in pressure and temperature of the steam within the casing, lowers the capacity of the unit, varies the strain due to centrifugal force on the elements, upsets the dynamic balance of the unit, and is likely to cause wearing out or destruction of the turbine blades.

If it were possible to prevent scale forming materials from leaving the boilers, the operator's difficulty with turbine blade deposit would be eliminated. On this theory, engineers turned to boiler water treatment for the answer and following an extensive survey Professor Frederick G. Straub of Illinois University in 1936 summarized his findings as follows:

1. The deposits were not limited to any one temperature or pressure.
2. The deposits were not proportional to the total concentration of solids in the boiler water.
3. The total solids in the steam were very low in many plants where deposits occurred.
4. The deposits all contained sodium as hydroxide, carbonate or silicate.
5. The deposits were practically all soluble in water.

This research project indicated that these water soluble deposits were the result of sodium hydroxide acting as a binding agent to stick the material to the turbine blades. If the sodium sulfate content of the boiler water was high in comparison to the sodium hydroxide, the deposition appeared to be prevented.

Since both success and failure followed the use of sodium sulfate in boiler water, the need for further investigation was indicated. In a recent report, Straub states that a new type of water insoluble deposit is being encountered which contains mainly silica (SiO_2). It predominates in the 400 to 550 F temperature range of the turbine. In many of the plants having topping units, this trouble occurs in the low pressure elements without much trouble in the topping turbine. In other plants, he reports, the topping turbine has the water soluble type and the low pressure turbine has the water insoluble type of deposit.

It thus became evident that the sodium sulfate boiler water treat-

Fig. 1. Appearance of silica type steam turbine deposits on the second stage low pressure diaphragm of a turbine

ment is effective for the water soluble deposits but has little effect in preventing the formation of insoluble deposits.

Salts Dissolved in Steam

One theory advanced to account for the presence of salts in steam going to the turbine is that the steam actually dissolves the salts and carries them in solution to the turbine. As the pressures and temperatures in the turbine decrease, a point is reached where the steam is supersaturated in respect to the salts and the salts crystallize out on the blades. Since different salts have different solubilities, the salts will separate in different stages of the turbine.

Straub has conducted extensive research work on this whole subject and has expressed the conclusion that data available regarding turbine blade deposits appears to indicate that:

(1) The insoluble silica deposits form in the temperature range between 400 and 550 F.

(2) The amount of silica deposits are not directly related to the soluble silica content of the boiler water.

(3) It is possible that a proper balance of the chemicals in the boiler water might reduce the silica deposits in the turbine.

Detecting Presence of Deposit

Since boiler water treatment has not, as yet, given the complete answer to the turbine blade deposit problem, the operator is forced to devise methods by which the scale can be removed with as little inconvenience as possible. In this procedure, the first step is to determine the presence of deposits on the blades. Three effects of accumulation are measurable while the turbine is assembled and in operation. These are: (1) increase in shell pressures; (2) reduction in efficiency; and (3) reduction in capacity.

B. D. Buckland of the General Electric Co. has stated that changes in these three characteristics can be detected by comparing the values obtained when the turbine is known to be clean, with those obtained at some later time when it is known or suspected that the turbine has accumulated deposits. Careful measurements of flows, shell pressures, steam conditions and load when the turbine is clean should be made as soon after installation as the turbine has attained its best operating condition.

This set of readings may then be used for comparison during the life of the turbine, see Figs. 3 and 4. When variations occur, the causes should be determined and corrections made. Gradual change in shell pressure is probably the most significant indication of an accumulation of deposit. Roughly calculated, the efficiency can be regarded as decreasing about 1 per cent for each weighted average 1 per cent change in shell pressure. For cases where the turbine is designed to handle small volume flow and the deposit extends to the exhaust, the decrease in efficiency will be closer to 1½ per cent, and for cases where the turbine is designed to handle large volume flow, and the amount of deposit is very great, the figure will be closer to ½ per cent.

Fig. 2. Silica type deposits on the ninth stage nozzles of a high-pressure steam turbine

Many successful operators favor examination of the turbine after the first year of operation and then lengthen the operation interval to approximately 10,000 hr between subsequent inspections. Such operators see the wisdom of developing a systematic and thorough procedure for checking and recording of wear, erosion and gradual deterioration, and from the data gathered at these times of inspection determine the desirable frequency of deposit removal periods.

Removal of Deposits

Four general methods are employed for removing deposits from the blades of turbines: (1) Cooling and contraction; (2) Washing with condensate; (3) Washing with caustic solution; (4) Blasting with fly ash or sand.

If in the normal operation of steam turbines, the units are shut down at regular and comparatively frequent intervals, this shutting down, cooling off and starting up process is usually very effective in removing deposits and maintaining clean turbine blading. The difference in expansion, due to changes in temperature, between the metal and the foreign material, causes the deposit to be cracked or flaked off. The condensate which forms during the shut-down period may also have a beneficial effect in cleaning the blades. Any other form of cooling than that due to normal operation is not recommended, for too rapid changing of the temperature of a turbine is liable to cause structural strains that can do serious damage to the unit. Starting and stopping should be done strictly according to directions given by the manufacturer.

Washing with Condensate

To remove soluble scale from turbine blades, the safest way is shut down the machine, let it cool thoroughly and then slosh the blade path with hot water. This method, however, requires several days so it is not frequently used. The more commonly employed method is to maintain the turbine in operation at reduced load, using desuperheated steam which is near the saturation point at the turbine throttle. As the steam passes into the turbine it begins to condense on the blades and the condensate dissolves and carries away the soluble materials in solution. This treatment is carried on for several hours which is usually sufficient to remove all the soluble deposits.

Care must be taken at the start and close of this treatment to

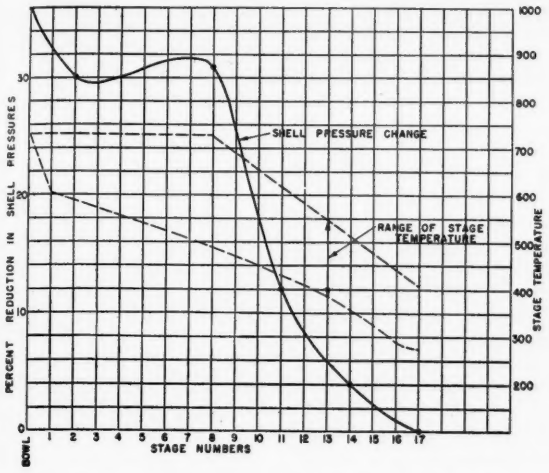

Fig. 3. One method of detecting presence of deposits is by comparing shell pressures of turbine in operation with pressures immediately following a cleaning. This curve indicates reduction in shell pressure due to removal of blade deposit from a high pressure turbine — 665 psia, 730 F steam at turbine throttle

change the temperature of the steam gradually, not more than 60 F per hour, so as not to put too severe a strain on the turbine. If not carried out properly, it may cause serious damage by distortion of the stationary parts. The Westinghouse Electric & Mfg. Co. states that washing by this method may be done at half load or less, but in any case with all governor valves open except in the case of straight reaction type turbines, in which case only the primary governor valve is to be opened. The lower the washing load the smaller the quantity of desuperheating water and, in general, the longer the washing period.

Specific directions for washing Westinghouse turbines by one method when operating at loads up to 50 per cent of rating are as follows:

A connection from the boiler feed line should be made to the main steam line at least 50 ft ahead of the turbine throttle valve, Fig. 5. The connection should lead into the pipe through a nozzle, or nozzles, to break up the water into a spray as it is admitted into the pipe. The spray should be directed against the direction of steam flow in the line. The number and size

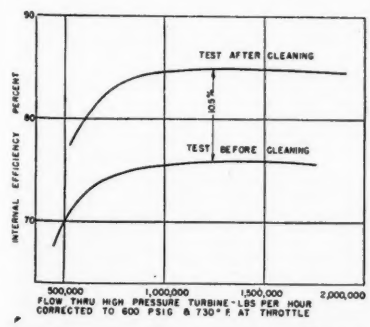

Fig. 4. Improvement in turbine efficiency due to removal of deposits

of the holes in the spray nozzle should be regulated so that, with the steam flow specified below and with full boiler feed pressure at the inlet of the nozzle, sufficient water can pass to bring the steam temperature at the inlet to the turbine to a point 10 F above saturation (corresponding to the pressure existing at the point at which the temperature is read.)

A steam pressure gage and a quick response thermometer (preferably of the continuous recording type) are to be located in the steam supply line adjacent to the throttle valve. These must be high grade and accurate instruments as they provide the criterion of proper desuperheating.

Set the turbine rotor in the "start and stop" position, if it is equipped with an adjustable thrust bearing, the adjusting mechanism of which is used in normal operation.

If the turbine has a ventilating steam supply line, close it.

Gradually close the header valve part way to lower the throttle steam supply pressure as the speed changer is advanced to fully open the steam inlet valves. The throttle steam pressure should be reduced until the desired washing load is carried with full open steam inlet valves. This adjustment should be made over a period of time varying between 15 min for a 10,000 kw turbine to 45 min for 75,000 kw turbines and larger.

Open all drains wide in the steam inlet pipe, throttle valve, turbine cylinder, extraction zones, dummy leakoff spaces, etc.

With the inlet valves fully open, the governor thereby inactive but capable of closing in an emergency, and steam header pressure sensibly constant, it should now be possible to control steam temperature accurately by water injection.

The operator should listen for rubs or unusual noises during the washing process, particularly when water is being admitted. Any increase in the amount of vibration should be noted. Arrangements should be made so that the water may be shut off immediately and the machine taken out of service should any rubs or other unusual conditions develop.

Admit water through the spray nozzles, gradually increasing the amount until the pressure and temperature at the throttle show 10 F superheat. Temperature should not be reduced below this value or all indication of water content may be lost. The rate of decrease of temperature must be uniform in small increments and must not exceed 60 F per hour. As a further criterion the cylinder thrust pedestal movements should be recorded. At intervals of an hour while desuperheating allow temperatures to stabilize to the point that the pedestal movement substantially stops, indicating that the cylinder temperatures are following the steam temperature changes closely.

When 10 F superheat is reached, operate for about 2 hr at this condition. Sampling the discharge from open cylinder drains will generally show the effect of washing and indicate when the process is complete.

After washing is complete, gradually shut off desuperheating water. The rate of steam temperature increase should be the same as specified for desuperheating.

Reverse the process of paragraph on lowering steam pressure to restore normal throttle steam pressure, taking the same time period.

Close drain lines 10 min after completion of washing.

If operating procedure calls for change of the turbine rotor axial position in normal rise, it should be restored to "running" position only after normal steam temperatures have been obtained.

If there is a ventilating steam line, open the ventilating valve.

Increase the load gradually and check the pressure distribution. The real test for the cleanliness of the blades is the pressure distribution. Readings should be taken before the washing operation, so that a full knowledge of the change effected will be available.

Washing with Caustic Solution

The removal of water-insoluble turbine deposits by caustic washing has been under investigation

by the American Gas and Electric Service Corp. for a number of years and the findings of these investigations and employment of the methods used were ably discussed by W. L. Webb and R. G. Call of that corporation in a paper presented at the 1943 Spring Meeting of the ASME. In this paper the authors stated that if steam-jet air pump nozzles were immersed in a boiling 10 per cent caustic solution for an extended period and then washed with water, the deposit was not removed. If, however, the nozzles were maintained at a temperature considerably above the boiling point of the solution and then were repeatedly wetted with the 10 per cent caustic solution and allowed to dry for about 15 min after each application, the deposits were readily washed off with water.

As a result of laboratory findings the piping arrangement shown in Fig. 6 was devised for use in the caustic-washing process as applied to a turbine unit at Windsor station. A 10 per cent caustic soda solution was used at the rate of about 2 gpm. While sufficient steam was admitted to hold the turbine speed between 100 and 200 rpm, the caustic solution was injected until the hotwell condensate, being dumped to the sewer, showed phenolphthalein alkalinity. This required 45 min. The stop valve was then closed, and the caustic solution allowed to react with the deposits for a period of about 15 min after the unit came to rest.

During the introduction of the caustic solution, the approximate steam conditions at the inlet to the stop valve were 230 psi, 550 F, and beyond the caustic-injection point

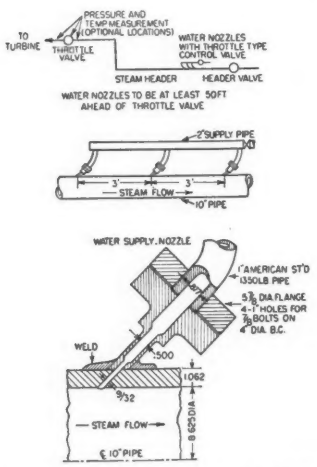

Fig. 5. Water nozzle location and details of design as employed for desuperheating steam while washing deposits from turbine under loaded condition

were 140 F to 200 F at a pressure slightly higher than the condenser pressure of 5 psia.

Eight additional 5 to 10 min shots of caustic solution were introduced while sufficient steam was being admitted to hold 100 to 200 rpm, each followed by the 10 to 15 min reaction period. The entire caustic washing period required about 3 hr and consumed 350 lb of flake caustic soda.

Steam was then admitted to the unit to maintain 100 to 200 rpm, and the condensate was injected at the caustic-solution injection point at a rate of about 2 gpm. After a 3-hr washing period, the hotwell condensate showed approximately normal conductivity and the unit was then returned to service. During the washing operation, samples of hotwell water were taken at intervals for analysis.

In their general recommendations regarding the caustic washing process which they also used in the Philo plant, Webb and Call made the following suggestions for those who wish to attempt the removal of water-insoluble deposits from condensing turbine units:

The method of introducing the solution should assure its thorough distribution over these surfaces. This is believed to be effectively accomplished by atomizing the solution and introducing it into the main steam flow.

The design of packing glands on turbine-stop and control valves should be carefully reviewed when the caustic-washing procedure is contemplated. Where the point of caustic-solution introduction is such as to permit the stem packing to be flooded with solution, some difficulty has been experienced with the sticking of stems and in removing the packing. This has occurred only on valves having stems which extend downward.

The foregoing precaution is also applicable to the more recent designs of packing glands which depend upon steam leak-off through close-clearance bushings. Water-washing was ineffective in removing the solidified caustic. Depending upon turbine design, the proper selection of the caustic-solution injection point may forestall this difficulty.

For low-pressure units, the caustic solution usually can be most conveniently introduced by gravity flow. However, if advisable, it may be pumped.

During the caustic injections, the shell drains should be closed and, during the subsequent washing with condensate, these drains should be open to the condenser.

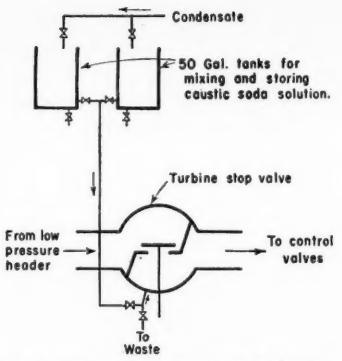

Fig. 6. Piping arrangement used for introduction of caustic soda solution and condensate to low pressure turbine during application of washing process

All turbine-instrument and bleed connections should be closed to prevent access of caustic to external equipment.

Excessive rates of temperature change of turbine parts should be avoided with the same care as used in normal operation.

To assure the removal of heavy deposits, it may be advantageous to repeat the entire washing cycle. As both physical and chemical characteristics of deposits are changed by caustic treatment, a unit so treated should not be returned to service before receiving a thorough water-wash. If a turbine is returned to service with heavy coatings treated by caustic, these coatings may become detached, causing damage to the unit.

Blasting with Fly Ash

When the deposits are of the water-insoluble and tenacious type, such as silica, authorities consider the most effective method of removal is by blasting them off with a jet of air into which fly ash is fed in amounts similar to the amount of sand used in sandblasting. This method has the disadvantage that the unit must be taken apart and is usually carried out during periods of inspection.

Ash found in the base of the stack has been found to be of satisfactory size and is preferable to sand since the fly ash removes the deposit and leaves a smooth satiny finish on the blading.

ESTIMATES made by the U.S. Department of Commerce indicate that nearly 3500 tons of metal will be consumed in 1943 for the fabricating of safety and relief iron valves, over 6000 tons for those made of steel, and over 4000 tons for those made of brass.

Water Conference

Nation's prominent water chemists meet in Pittsburgh for Fourth Annual Water Conference sponsored by Engineers' Society of Western Pennsylvania for discussion of problems in corrosion, water heating equipment, wells, softening processes and regenerative characteristics met with industrial waters

FOR THE fourth consecutive year the Engineers' Society of Western Pennsylvania has conducted a water conference under the chairmanship of H. M. Olson. The sessions this year were held in Hotel William Penn on November 1 and 2 with an attendance in the neighborhood of 300 men including research chemists, engineers responsible for purification of water for industrial uses, boiler water specialists and engineers engaged in designing water treating equipment for all purposes. Many of the papers were highly technical as they dealt with the science of water treatment from a chemist's viewpoint. They reveal distinctly that definite progress is being made in this most complicated problem of preparing water for industrial and domestic uses.

Corrosion due to water, for example, is recognized as one of the most destructive agencies encountered in industry. In recent years, chemists have been working with chemical agents known as inhibitors that either prevent or retard the corrosive action that takes place in piping or metallic vessels used for containing water. One of these chemicals is marketed under the trade name of Calgon upon which data were presented by Owen Rice to show how protection against corrosion is afforded. It was pointed out that corrosion is a surface action and the inhibiting agent must therefore protect that surface. Thus the amount of chemical necessary is dependent on the amount of surface to be protected rather than the amount of water to be treated. He also described tests being conducted to determine the rate of corrosion that takes place in various types of water under varying conditions of temperatures, pressure and agitation.

In the equipment line, deaerating feedwater heaters have for years been used effectively for removing oxygen from the water as a protection against internal corrosion of steam boilers. Inasmuch as the customary acceptance test methods were not considered satisfactory by the U. S. Navy, a new method of testing has been worked out by the Navy in conjunction with manufacturers and the Conference was privileged to have this test procedure described in detail by R. E. Adams of the Naval Experiment Station. The significance of all variables in the operation of deaerating heaters was discussed with the conclusion that only two of a total of five were of importance, these are the operating pressure and the rate of water flow. Manufacturers reported that they had complied with the wishes of the Navy in testing the equipment they supplied even though the test requires a special layout to control the steam and water necessary, and the cost of the test, estimated by some as between $20,000 and $30,000, is thought to be so high that the method will not be adopted as a commercial standard.

Bacterial Corrosion

Among the newer theories about corrosion, which is well substantiated by data gathered in research work, is that bacteria play an important part. This subject has been under investigation by A. E. Griffin of Wallace & Tiernan Co. who stated that at first it appeared that not more than two or three organisms were responsible for corrosive damage to iron and steel but new evidence has been presented to show that many types of organisms are involved. These range all the way from members of the coli aerogenes group to the more specialized type known as the desulphuricans. In order for bacteria to gain a foothold there must first be seed and secondly food. The seed are usually present in the water or gain entrance en route to the customer. Two lines of attack are open: (1) remove the food, (2) kill the organisms. The first is difficult and costly, the second simple and relatively economical. Disinfection with chlorine was recommended by Mr. Griffin to combat bacterial corrosion and sliming difficulties.

Corrosion that takes the form of pitting is typical of that caused by bacteria. These bacteria, it is explained, contain hydrogen sulphide and as the clusters form and die they build up formations similar to barnacles attached to the metal surface. Under these clusters, the corrosive effect of sulphuric acid has been noted, as reported by some of the discussers.

Corrosion Due to CO_2 in Steam

To the man who handles condensate such as the returns from steam heating systems, pipe corrosion is a serious problem and many studies have been made to determine the causes and to devise remedies. At this Conference, Leo F. Collins of the Detroit Edison Co. describes studies made to combat the corrosion due to CO_2 dissolved in the condensate. It is felt that stratification accounts for the fact that frequently more CO_2 is found dissolved in the condensate than theoretical calculations predict. He reported that tests of the comparative corrosion resistivity of several metals show that the copper alloys commonly used in condensers, water heaters, blast coils, and the like are not immune to corrosion; that tin, aluminum, stainless steel and Inconel are immune.

Mr. Collins suggested that fundamental research, looking to the development of a water treating method by which CO_2-free steam can be produced upon a commercial basis, when carbonate bearing boiler feedwaters are used, is a present day need.

Science has gone a long way since the days when the divining rod was given credit for locating underground water supplies. Today the scientists turn to geophysics for such purposes and for solving many of the problems that arise in drilling, completing and producing water wells. Carl A. Buys of the Illinois State Geological Survey gave the Conference an extremely interesting lecture on the work geophysicists are doing in interpreting both surface and subsurface surveys made by the use of modern instruments to determine the characteristics of underground water supplies. Such information has proved invaluable in determining what measures should be taken to remedy defects in wells and to plan more intelligent developments of groundwater resources in the future.

Progress in Water Treatment Equipment

Once the principles of a water treatment system have been proved correct, the commercial application of those principles becomes a problem of industry in the solution of which both the equipment manufacturer and the user have parts

(*Continued on Page* 140)

INDUSTRIAL ELECTRONICS Today and Tomorrow

INDUSTRIAL ELECTRONIC equipment is playing an indispensable role today in America's record-breaking war production. According to General Electric officials, speaking at a conference on industrial electronics at Schenectady on September 14, the application of electronic devices in industry has been directly responsible for the saving of millions of man- and machine-hours and millions of pounds of critical materials since Pearl Harbor.

The conference reviewed what electronics has done, what it is doing and what it can do in industry. Far from being a new industry, it was pointed out that electronics has already come to maturity in industrial operations. L. A. Umansky, assistant manager of G.E.'s Industrial Engineering Division, who spoke on the broad aspects of industrial electronics, called attention to the fact that 1943 will see 25 billion kwhr of electrical energy passing through electronic devices. He told how the application of electronics has brought about profound changes in many of our manufacturing industries, giving as an example the contributions of electronic control to bring about previously unknown precision, speed, and reliability to resistance welding operations, thus making possible the mass-production fabrication of many of today's implements of war. Mr. Umansky said that General Electric looks upon electronics as another tool—a very important one, to be sure—added to its well-filled chest and to be used side by side with other tools on hand. In a true perspective of things, electronics has taken its place as an equal partner, side by side with other electric equipments, enhancing rather than superseding them.

In its broad sense, electronics includes all electrical phenomena, for all electric conduction involves electrons. The common interpretation of the term at present, however, includes only the process of conduction of electricity through vacuum by electrons alone, or through a gas by electrons and ions. This involves the use of tubes—tubes of either glass or metal.

Electron Tubes

Among the first of the speakers at the conference, was W. C. White of the G.E. Electronics Laboratory. His particular subject was electron tubes. In describing the variety and versatility of modern electron tubes, Mr. White stated that tubes are available that will detect and measure currents of far less than a billionth of an ampere. Others will carry thousands of amperes. Similarly, voltages of a millionth of a volt can be detected and amplified, and rectification up to one hundred thousand volts provided for. On the frequency scale, tubes are available to provide frequencies up to about a billion cycles. Physically, some tubes are so small that they will fit into a thimble; others are bigger than a man.

In the fundamental classification of tubes, there are only four basic component variables: (1) The nature of the cathode that emits the electrons; (2) the nature of the content of the envelope; (3) the number of electrodes; and (4) a special feature sometimes added to the first three basic components to adapt a tube to some particular use. Under this classification, the ignitron is a pool-cathode, vapor-content, three-element tube.

There is something pathetic about the current wave of public interest in, what is generally spoken of as "electronics". Without knowing exactly what electronics means, all sorts of people are talking about it, telling each other how it is going to re-make the world after the war, how it is going to develop into a great new postwar industry, and how, along with plastic houses and helicopters it is going to relieve us of all drudgery. Electronics, Brother, it's wonderful!

About three times a week we meet somebody who has just talked to Col. So and so, or Major Something or other, or, maybe, it was only a no-account corporal in the Signal Corps who vaguely hinted about strange, secret developments, which if they were disclosed to us would tie our imaginations into tight knots. Or, they have just had a conference with someone who knows someone in some laboratory where the researchers throw each memorandum or development sketch they make into the fire before the ink is dry—the work is so secret, the developments so startling. All electronics, of course.

If, upon hearing these things, we look skeptical or gently venture to imply that maybe some of these stories may be slightly exaggerated, that, perhaps, some of these things they hear about are not quite so new as they seem to believe they are, they regard us with a mixture of scorn and mild offense—didn't they just talk to these people? And, don't we know about radar? Didn't our navy sink a Jap warship, unseen, unheard one dark and stormy night, and didn't the Germans put a shell neatly into the magazine of the British Battleship Hood at a distance of upteen miles? Don't we know these things; and if they are not radar, what are they? If things like these can happen, why isn't electronics going to do all the things the copy writers say it is?

Usually we do not argue. After all, these people who tell us these things, often know what an electron is—a little black ball whirling around inside an atom in elliptical orbits—so who are we to say anything about the subject? They have seen pictures of these electrons in the ads. Of course, we could venture the opinion that maybe the destruction of the Hood was the result of just good marksmanship, or perhaps a lucky shot; that even if the guns were directed by radar, that still would not account for the direct hit on the magazine. But, of course, we don't know anything about radar and even if we did we could not talk about it. So we just do not say anything, except that, it's wonderful!

Yet, we cannot remain entirely passive either. The fact is, some of us happen to know a little about electronics because of an early interest in wireless telegraphy which later became radio. Vacuum tubes have been more or less familiar objects for many years and we have always had them around the house to monkey with. So we feel that all this high powered whoopla about electronics needs a bit of debunking.

Last month, in an editorial on the subject, we endeavored to deglamourize electronics somewhat and to present it to the readers of Power Plant Engineering for what it is; an extremely useful industrial tool, by no means new, but capable of much further development.

In this purpose we are not alone. Our respected contemporary "Electronics" has been doing the same thing for many months as have other publications closely allied with the electronics field. On September 14 the General Electric Co. held a special Press Conference on Electronics to which the editors of most of the leading technical and trade magazines were invited. The purpose of this conference was to acquaint the editors with the facts regarding electronics and to show how great a part General Electric had played in its development. As will be noted from the accompanying report of this conference considerable emphasis was placed on the fact that electronics was not something new but that it had been developing for thirty years and that it was already a great industry.

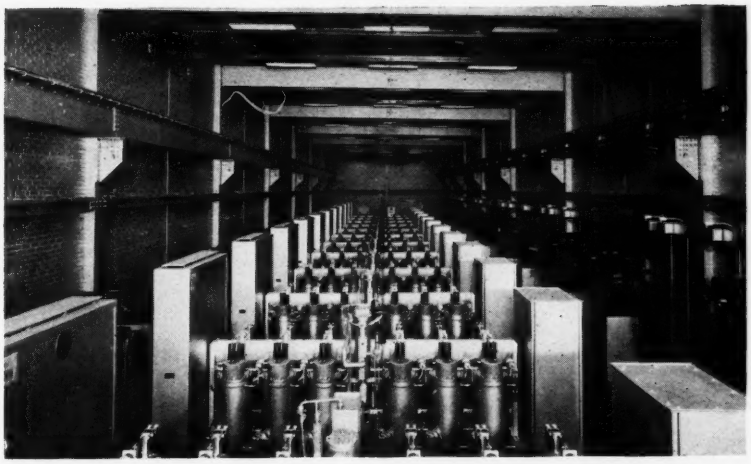

Fig. 1. A twelve unit ignitron mercury-arc rectifier installation in a large electrochemical plant. The rectifier units are rated 5000 amp, 645 v (3225 kw)

The usefulness of the electron tube as a circuit element is based upon many characteristics but in general, according to Mr. White, these can be reduced to certain rather simple fundamentals. The first of these is the tube's almost complete independence of action as regards circuit frequency. A vacuum tube can function at millions of cycles a second just as well as at 60 cycles. The second is the ability of the electron tube to control electrical currents smoothly, without the steps required by other devices to vary an electric current.

The third feature is their ability to amplify and the fourth their ability to pass current in one direction only or, as it is often expressed, to act as a rectifier.

"The present trend in tube development appears to be along the line of stepping up their characteristics over a several-fold range, so that future tubes and their associated circuits will be able to handle currents several times as heavy as present tubes now handle," Mr. White said. "It will mean that frequencies ten times as high as those in common use can be generated and utilized. Working in the opposite direction, there will be a trend toward tubes that fundamentally respond to weaker impulses, that is, have a high degree of amplification or that will time electrical circuit operation for much shorter periods and with much greater accuracy than we now enjoy."

Power Conversion and Frequency Changing

The application of electronics in power conversion and frequency changing was discussed by L. W. Morton of the Industrial Engineering Division of G.E.

Electronics as applied to power conversion means rectification, or the conversion of alternating-current power supplied from an a-c system to direct current for d-c power utilization processes or systems, explained Mr. Morton. The predominant equipment in this field is the mercury arc rectifier which utilizes tubes using mercury vapor as the gas. The mercury arc action is of such a nature that current cannot flow through the vapor when the anode is negative with respect to the tube's cathode, which is really a pool of liquid mercury.

In this application, the ability of electron tubes to pass current only in one direction is put to work. The a-c system is connected to anodes and as each anode becomes positive it conducts unidirectional or direct current, thus resulting in a continuous flow of direct current from the tube cathode.

Mr. Morton pointed out that the mercury arc power rectifier is one of the oldest electronic devices. Mercury arc rectifiers were used on street lighting circuits for many years before the First World War. An early General Electric commercial application was made in 1924 when a 500-kw multi-anode rectifier was installed in Albany, N. Y., to convert power supplied to 600-v street railway service. Since then there have been installed in this country, several million kilowatts of rectifiers of steadily improved design and efficiency to electrometallurgical and electrochemical processes, transportation service, steel mills, mines, printing press drives, shipyards, cracking processes, and to convert power for cranes, elevators, ore bridges, and car dumping—to mention some of the most important applications.

"The application of electronics in the shape of power rectifiers has expedited the recent expansion of facilities for producing light metal in two ways," said Mr. Morton. "If electronic power conversion equipment had not been available, industry's requirements for 2,500,000 kw of conversion apparatus for aluminum and magnesium would have had to be met by rotating equipment. The facilities for the manufacture of rotating equip-

Fig. 2. A 15-kw electronic heater used for inductive heating of small metal parts. The small gear will be heated for 3.2 sec, then quenched in the fixture shown. The hardened zone is uniform and follows the contour of the gear, with the core of each tooth remaining soft

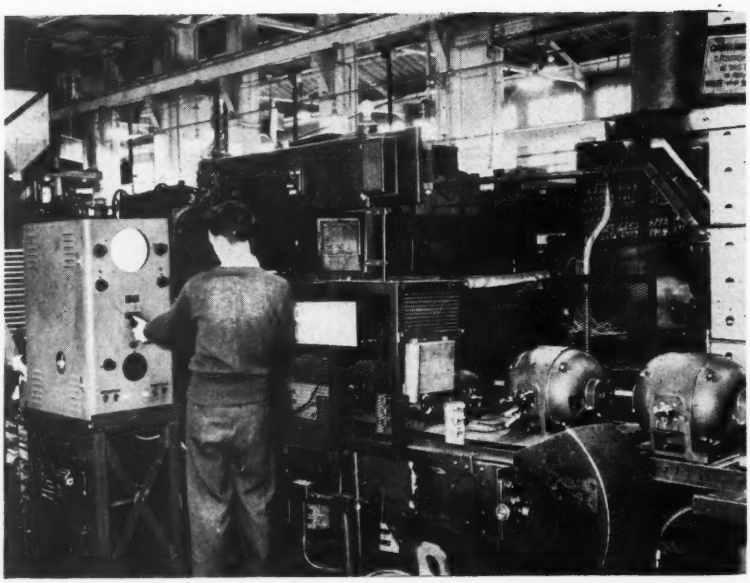

Fig. 3. General Electric electronic insulation tester shown at work on a production line testing of turn-to-turn insulation of new motors. Through the use of an electronic pulse generator, this instrument subjects the motor windings to a rapid succession of momentary high-voltage stresses such as those caused by lightning or switching. Performance of the winding under stress is transmitted to the cathode ray tube. If the windings are electrically symmetrical, one cathode ray trace will be seen; if the insulation is weak, two traces will appear

ment were so heavily taxed by other war requirements that the addition of this additional requirement would probably have delayed the light metals program for several months.

"In addition," he pointed out, "since rotating conversion apparatus requires roughly 50 to 100 per cent more steel and 25 to 75 per cent more copper than electronic rectifiers, it has been estimated that more than 40,000,000 lb of steel and 3,750,000 lb of critical copper have been saved for other industrial fronts."

Mr. Morton pointed out that the same principles used in converting power from a-c to d-c could be slightly modified to convert d-c to a-c. Thus, by combining two rectifier equipments, one for use as a rectifier to convert power from an a-c supply to direct current and another to change that d-c power to a-c and deliver it to another a-c system, power can be transferred between two a-c systems of different frequencies.

A pioneer d-c transmission system built by General Electric and operated by the New York Power & Light Corporation has been in operation for several years and takes power at 40 cycles and delivers it to another system seventeen miles away at 60 cycles.

Early this fall, General Electric will place in service an electronic frequency changer rated 20,000 kw which will connect a large steel company's 25-cycle power system and the power company's 60-cycle system. In this case, the d-c link will be less than 12 ft long. The apparatus will be able to deliver constantly any desired kilowatt rate within the 20,000-kw rating from either system to the other.

Electronic Measurements

In few branches of the electrical art outside of communication has electronics been of greater value than in the field of measurement. Electronic measurements were presented at the G.E. conference by W. C. Hutchins, manager of the Special Products Division.

"To get an accurate record of machine performance and to record the progress of scientific investigations, measurements must be made," said W. C. Hutchins. "Progress has many times been stymied because of the need for more sensitive and more accurate measuring equipment. In many cases the solving of these measurement problems appeared to be impossible until electronic equipment was used."

Mr. Hutchins described a few of the many electronic instruments that have been made available to industry to perform a wide range of testing and measuring. He told about the new G.E. electronic winding insulation tester which is helping to make better motors. By simulating unusual stresses to which the motor may be subjected after installation, such as those caused by lightning or switching, this instrument makes it possible to detect damaged insulation in the motor windings.

The measurement of sound is essential in the manufacture of quiet operating apparatus, whether it be an air-conditioning equipment in a theatre, or war equipment that must be quiet to prevent giving away the positions of our soldiers to the enemy. A sound-level meter, utilizing a specially designed microphone in combination with an electronic circuit, has made it possible to convert the noise or minute sound pressure waves to an accurate, numerical value.

The electronic vibration velocity meter has made it possible to measure and analyze vibrations in high-speed machines more accurately than was possible without the use of the electron tube.

Heat exchangers, with water flowing through tubes and air passing over the outside, are required for successful operation of submarines and battleships. Since a leak in one tube may cause thousands of dollars damage, testing of these brass tubes became a very important part in manufacture. After conducting every conventional test, faulty tubes were still getting into the finished heat exchangers. The replacing tube cost only $1, but the cost to install the tube amounted to $250. The G-E tube-flaw detector, a high-frequency electronic equipment, was installed. The saving resulting from the rejection of tubes with flaws before the tubes were installed, saved the price of the installation in less than three months and speeded up production of these vital heat exchangers.

"The science of electronics," said Mr. Hutchins, "has enabled the engineer to build equipment that is almost human in that he has practically duplicated four of the human senses. To illustrate, the mercury vapor detector simulates the sense of smell; the sound level meter the sense of hearing; the vibration meter the sense of touch; the photoelectric tube the sense of sight, even to the extent of distinguishing colors more accurately than is possible with the human eye.

"It is a fact that during the last ten years the application of electron tubes to measurement problems has enabled the engineer to design and build equipment for war and peace that otherwise would have been impossible."

Electronic Heating

Electronic heating, discussed by J. P. Jordan of the G.E. Electronics Heating Section, covers the application of high-frequency vacuum tube oscillators to two broad fields: the induction heating of metals and the dielectric heating of nonmetallic materials such as plywood, plastics, and foods. Although the equipments for both applications are somewhat similar, the methods of heat generation and its effects on the charge differ widely.

In induction heating, Mr. Jordan explained, the part is placed in or adjacent to a water-cooled inductor coil which carries a high-frequency alternating current. The magnetic field thus produced induces a current in the surface of the part and causes it to be heated. This heat is generated entirely in a surface layer, the depth of which is determined by the frequency used.

On the other hand, in dielectric heating the material is placed between two plates, thus forming a capacitor; a high-frequency voltage is then applied and considerable power in the form of heat is distributed throughout the material being treated.

"On the basis of cost per kilowatt of heat generated," Mr. Jordan explained, "electronic heaters represent at the present time the most expensive form of heat obtainable. Due to the emphasis being placed on electronics today, it would be all too easy to select such equipment for applications which later would prove to be uneconomical and thus prejudice the further use of electronic heaters. Therefore, it is important that electronic heaters be applied only to those processes where their unique characteristics can be used to best advantage."

Mr. Jordan went on to point out that since this type of heat permits its concentration on the surface of sharply defined areas, it is invaluable in the surface hardening of gears, bearings, and other parts subject to surface wear. Previously, such parts were either hardened throughout, thus sacrificing ductility and toughness, or were case hardened by standard methods involving several time-consuming operations and often resulting in distortion and scale.

In the brazing field, the main advantages are uniformity of results and automatic operation, independent of the operator's judgment. Electronic heaters always produce the same temperature in the same area.

In the dielectric heating field, the gluing of plywood and the preheating of plastics are the major applications to date. When gluing relatively thick sections of plywood in a steam press, the rate of heat transfer through the mass is very slow, thus the surface must be held at temperature for periods up to several hours before the center is heated sufficiently. Electronic heaters raise the temperature uniformly throughout the mass, thus eliminating heat conduction as a factor and greatly reducing the heating time required.

In the molding of thermosetting plastic parts, it has heretofore been necessary to place uncured plastic pellets in a mold while the pellets were relatively cold. Efforts to heat them with hot plates or infrared lamps prior to molding resulted in the outside surfaces being cured before the interior was appreciably heated. With dielectric heat, the entire mass can be brought to a high temperature without danger of localized curing.

Electronic Control

E. H. Alexander of the Industrial Control Division stated that no single industrial electronic equipment has contributed more to war production than resistance welding control.

An important recent contribution to the art of resistance welding control is the electronic current-regulating compensator. The current regulator compensates for variations in line voltage and for the amount of magnetic material in the throat of the welding machine, thus making it possible to obtain consistent welds in welding parts of irregular and varying shapes.

The increased use of aluminum alloys, especially in heavy gages, has brought forward the energy storage method of resistance welding to supply the very high currents required by these materials. In this system, an electronic rectifier takes power from a-c lines and converts it to direct current which is stored, usually in capacitors. The voltage stability of the power supply is thus greatly increased since the current demand is reduced and the load divided over three phases.

Describing G-E's electronic motor control drive, the Thy-mo-trol, Mr. Alexander explained that with this drive it is literally possible to make a d-c motor do useful tricks with power supplied from an a-c line. Thyratron tubes change the a-c power to d-c, and make it possible to operate the motor over a wide speed range and start, accelerate, decelerate, regulate, and reverse, simply by turning a tiny dial or pushing small buttons. Although the Thy-mo-trol system was introduced only two years ago, hundreds of these drives are now helping speed war production.

"Automatic timing of industrial processes has always been an important problem," said Mr. Alexander. "The seemingly simple job of accurately measuring incre-

(*Continued on Page* 138)

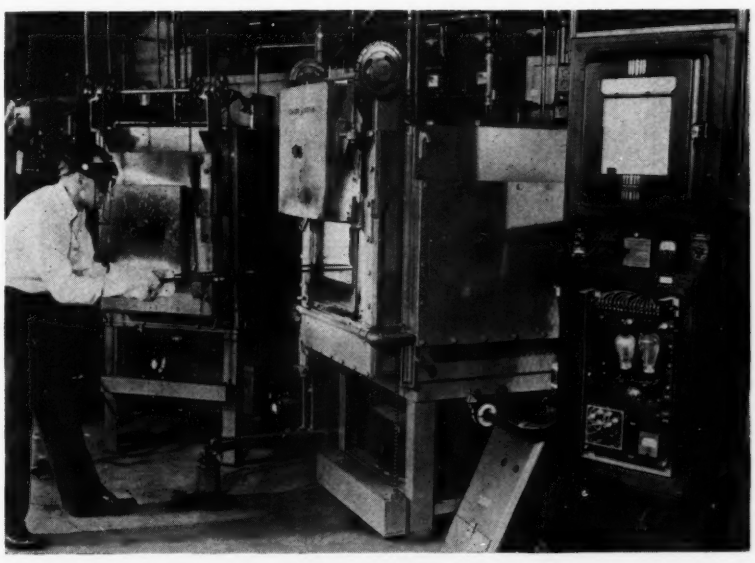

Fig. 4. Electron tubes on a G.E. Reactrol panel at the right of furnace, operating in conjunction with a thermocouple-type control equipment and a saturable reactor, modulate power input to high-temperature furnace to provide precise temperature regulation

Motor-Driven Boiler Feed Pumps— CONSTANT OR VARIABLE SPEED?*

Because of the relations between flow, pressure generated by a boiler feed pump and other pump characteristics, it is necessary to consider whether such pumps should be driven at constant or variable speed. The author discusses these factors in detail, also the relation of drive to selection of feed pump, pump characteristics and control of the pump. He then gives a detailed analysis of a comparison between a 3600-rpm, squirrel-cage-motor-driven pump and an 1800-rpm, slip-ring-motor-driven unit. The decision is in favor of — but why not read the whole story and see if you agree with the author?

By Igor J. Karassik

Application Engineer, Worthington Pump & Machinery Corporation

IF BOILER FEED PUMPS were destined always to operate at a given constant flow or if, like reciprocating steam pumps, centrifugal pumps were able to develop at all flows just that pressure which would be sufficient to feed the boiler, the problem of variable speed operation would not exist. Unfortunately, neither of these suppositions corresponds to the actual facts. One of the most important requirements in the operation of modern steam generating units is the maintenance of a constant water level in the boiler drum, irrespective of the fluctuation of the load imposed upon the boiler. Boiler feed pumps, therefore, are called upon to operate in a very wide load range, all the way from practically shut-off to full load.

At the same time, the pressure generated by a centrifugal pump at constant speed increases with a decrease in capacity, the rise in pressure between full load flow and shut-off conditions ranging anywhere from 10 to 30 per cent. On the other hand, the pressure required to feed the boiler, being made up of the boiler pressure itself and of the frictional losses in the piping, through the heaters and across boiler controls, decreases appreciably with a reduction in flow. The difference between the pressure required to feed the boiler and that generated by the boiler feed pump must therefore be considered as useless —see Fig. 1—and means must be considered to dispose of this excess pressure.

Excess Pressure

The presence of this excess pressure is undesirable for several additional reasons. Unless it is eliminated in some manner, this excess pressure must be absorbed in the feedwater regulating valve. This results in a very wide variation in the pressure drop across this valve, a variation that imposes severe fluctuations in flow through forces external to changes in boiler level. At low loads, the regulating valve is made to operate through a very small portion of its travel, with a resultant sacrifice in accuracy of control.

In addition, it must be considered that the feedwater piping, as well as any closed heaters located downstream from the boiler feed pump, are subjected to a maximum pressure corresponding to the shut-off pressure of the pump, which is considerably higher than would be the case if the feed pump pressure did not rise above that required to feed the boiler at full load.

Elimination of this excess pressure can be accomplished either by:

(1) Throttling the excess pressure generated by the feed pump, the latter being operated at constant speed, or

(2) Decreasing the pressure generated by the pump at various loads, by varying the pump speed.

On first examination, it would appear that regulation of the boiler feed pump capacity by throttling the pump discharge is inefficient in that it is wasteful of energy and that the more efficient solution lies in adjusting the speed of the pump. Since first impressions have a frequent and unpleasant habit of leading to erroneous conclusions, the safer course will lie in a careful examination and evaluation of the actual facts.

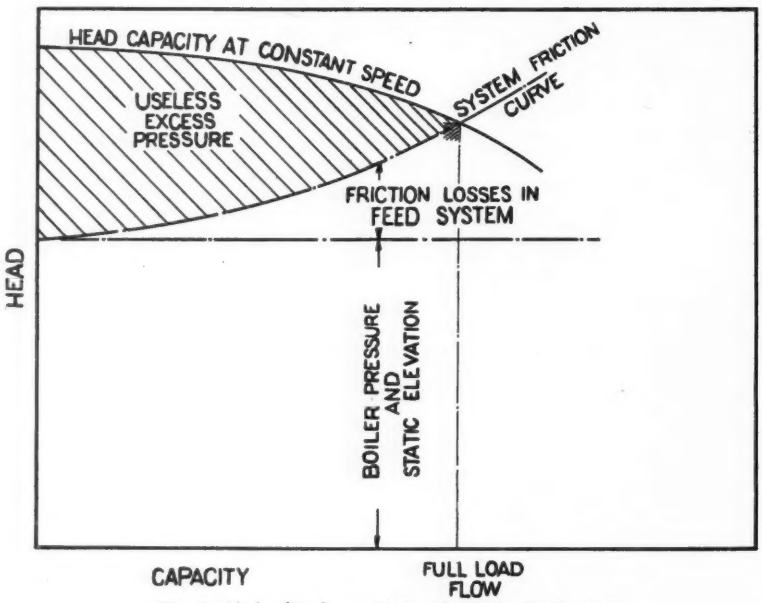

Fig. 1. Hydraulic characteristics of a boiler feed system

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Methods of Varying Speed

Adjustable-speed boiler feed pump operation can be accomplished in three ways:

(1) By steam turbine drive,
(2) By the use of slip-ring variable speed motors,
(3) By the use of hydraulic or magnetic couplings in connection with constant-speed squirrel-cage motors.

Use of a steam turbine with a variable-speed constant pressure or constant-excess-pressure governor affords the ideal motive power for boiler feed pump drive in this particular respect. The turbine runs at pump speed, without any external speed changer or gear. The steam consumption is reduced almost in direct proportion to the power demand, as turbine water-rates are but little affected in the relatively narrow range of speed variation encountered between full load and shut-off. As a result, there is no question in this case that variable speed operation is by far the most efficient and most logical from the point of view of pressure reduction.

However, steam turbine drive is not applicable under all conditions. The choice between turbine and motor driven depends upon the following factors:

(1) Availability of either source of motive power,
(2) Relative operating cost, including appropriate credit for the turbine exhaust steam,
(3) Relative dependability and freedom from interruption,
(4) Relative first cost.

Our problem does not concern itself with the actual method of effecting this choice, but rather in the evaluation of variable versus constant-speed operation in the event that steam turbine drive is not suitable for one or another reason.

Effect of Drive on Pump

The first effect of the choice between the two methods of operation is that on the selection of the boiler feed pump itself. For constant-speed operation, the boiler feed pump would be directly driven by a squirrel-cage motor, while to obtain the required speed regulation it becomes necessary either to apply a slip-ring motor or to use a squirrel-cage motor driving the feed pump through a hydraulic or magnetic coupling.

While two-pole 3600-rpm slip-ring motors are available, they are considerably more expensive than 1800-rpm motors and, generally, not as reliable. Likewise, there has not yet been developed a satisfactory hydraulic coupling to operate at 3600 rpm in the horsepower range required. A boiler feed pump, on the other hand, is inherently more efficient, more compact and less expensive if it is designed to operate at 3600 rpm.

Pump Characteristics

It has been frequently argued that the lower-speed boiler feed pump will have a flatter head-capacity curve, and a horsepower curve that drops off faster towards shut-off, than a high-speed pump designed for the same conditions of service. This feature would negate, to a certain extent, the saving in power resulting from the higher efficiencies of higher speed pumps at the design capacity, since a feed pump will be frequently operated at reduced loads.

Such an argument, however, is not entirely valid. In the first place, the pump designer has considerable leeway in the actual shape of the head-capacity curve through his control of impeller angles and areas and can vary the rise of the head-capacity curve towards shut-off at any speed. Thus, in checking over a large number of test data it was found that 3600-rpm high-pressure boiler feed pumps have been designed and tested with a rise from design condition to shut-off of as low as 8 per cent and as high as 30 per cent, while 1800-rpm feed pumps have been made with a rise of as low as 8 per cent and as high as 26 per cent. This clearly indicates that a designer can control this rise within reasonable limits independently of the operating speed.

In addition, there is a definite danger in reducing the percentage of rise towards shut-off because of the difficulty of controlling a feed pump when very small changes in generated pressure correspond to large changes in flow. This danger is further increased by the tendency of relatively flat head-capacity curves to exhibit a drooping characteristic at low flows—a feature distinctly unfavorable for parallel operation. Thus, for instance, the head-capacity curve of the 3600-rpm pump illustrated in Fig. 3 shows approximately 17 per cent rise to shut-off and it is not practical to reduce the rise much below this amount.

This should not be construed to mean that a pump designer will vary the rise of the characteristic curve for every installation, for such practice involves longer deliveries and increased first costs. This control over the shape of the characteristic curve

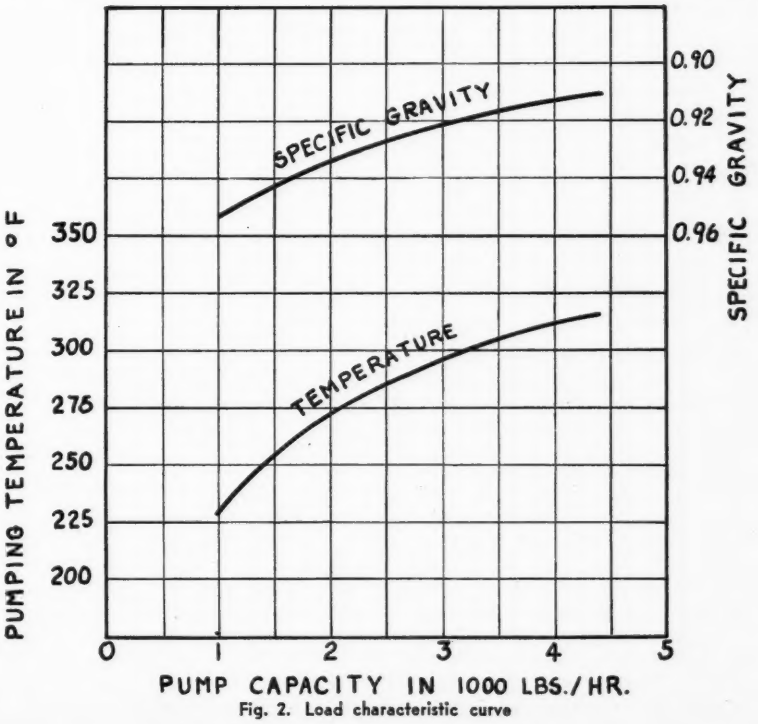


Fig. 2. Load characteristic curve

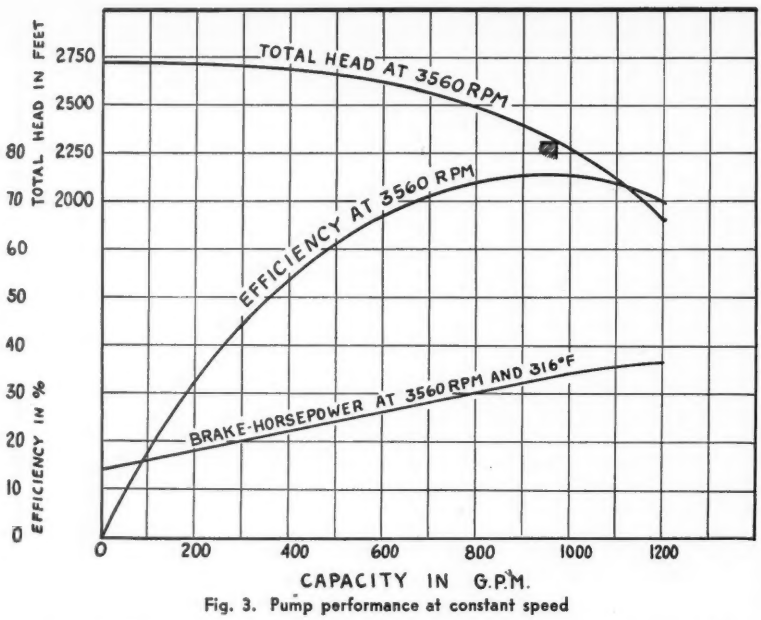

TOTAL HEAD IN FEET
EFFICIENCY IN %
TOTAL HEAD AT 3560 RPM
EFFICIENCY AT 3560 RPM
BRAKE-HORSEPOWER AT 3560 RPM AND 316°F
CAPACITY IN G.P.M.

Fig. 3. Pump performance at constant speed

is exercised at the time of the original design, that shape of curve being selected which will give the most suitable and reliable operating features for the particular pump in question.

Evaluating a Specific Case

In carrying out the desired evaluation between constant and variable-speed operation, it was decided to consider only the case of a 3600-rpm unit driven by a squirrel-cage induction motor versus that of an 1800-rpm pump driven by a slip-ring, variable-speed motor. It was felt that if the case can be proved in favor of one or the other method of operation, it would also hold true with respect to the hydraulic coupling operating at the same speed of 1800 rpm. This assumption was based on the well known facts that the efficiency of a hydraulic coupling bears the same relation to the speed of the driven equipment as does the efficiency of a slip-ring motor and that the initial cost of the slip-ring motor and of a drive including a hydraulic coupling are relatively of the same order of magnitude.

A set of service conditions was assumed in order to carry out the desired evaluation. The design pump capacity was selected as 440,000 lb per hr of water at a full load temperature of 316 F. The vapor pressure in the feedwater heater, corresponding to this temperature is 70 psi gage. If the discharge pressure is 1000 psi gage and the pump is supplied with a net positive suction head of 45 ft, the required total head becomes 2307 ft. The assumed load characteristic curve of the station is illustrated in Fig. 2 and the performance of a 3560-rpm pump at constant speed in Fig. 3.

In carrying out this analysis, additional assumptions had to be made. It was assumed that the efficiency of an 1800-rpm pump would be 5 points lower than the efficiency of the 3600-rpm pump. The motor efficiency of the 700-hp, 3600-rpm squirrel-cage motor was taken as 0.94, 0.93 and 0.91 at full, ¾ and ½ load respectively. The efficiency of the 800-hp, 1800-rpm, slip-ring motor (required because of the lower efficiency of the 1800-rpm pump) was taken as equivalent to that of the 700-hp, 3600-rpm, squirrel-cage motor. It was assumed that power costs average 0.5 cents per kwhr. Finally a total operating load of 8000 hr per yr was selected. Because of the tendency to select feed pumps with sufficient capacity margin, it was assumed that the subdivision of operating hours is:

Lb per hr	Operating hr per yr
440,000	500
300,000	3500
200,000	3500
100,000	500

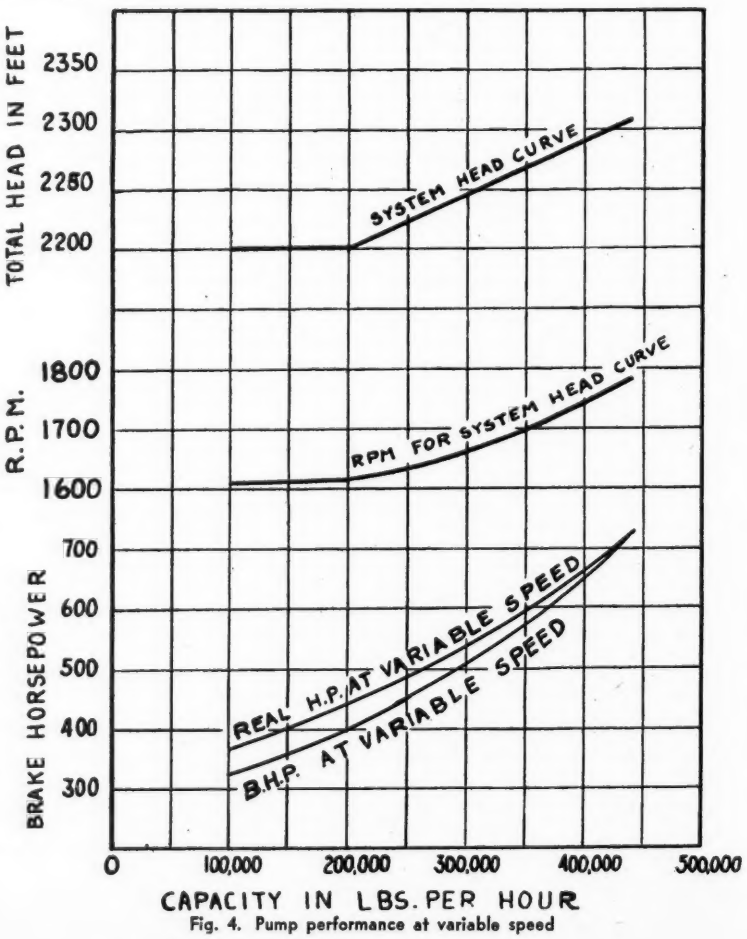


Fig. 4. Pump performance at variable speed

Table I—3600 rpm constant speed

Lb/hr	Temp in F	Specific Gravity	Gpm	Total Head in ft	Eff in %	Bhp	Kw Input
440,000	316	0.91	970	2307	76	675	536
300,000	296	0.922	650	2600	70	562	450
200,000	272	0.933	429	2670	57	474	382
100,000	228	0.953	210	2700	35	392	320

Table II—1800 rpm variable speed

Lbs/hr	Temp in F	Gpm	Total Head in ft	Rpm	Eff in %	Bhp	Real Hp	Kw Input
440,000	316	970	2307	1780	71	724	724	576
300,000	296	650	2245	1665	67	506	541	436
200,000	272	429	2200	1612	55	399	441	359
100,000	228	210	2200	1610	34	327	362	298

Table III—Comparative operating data

Lbs/hr	Excess of KW input at constant speed over Kw input at variable speed	Operating hours per year	Excess in Kw-hr per year
440,000	—40	500	—20,000
300,000	14	3500	49,000
200,000	23	3500	80,500
100,000	22	500	11,000
	TOTAL	8000	120,500

Comparison of Performance

Based on an assumed system head curve, the performance of the 1800-rpm variable-speed unit is shown on Fig. 4. The comparison of power savings must be made between the brake-horsepower consumption at constant speed and the "real horsepower" at variable speed, since the efficiency of a variable-speed slip-ring motor is reduced proportionally to the speed at which it is operating and, therefore, the actual horsepower consumption is greater than indicated by the brake-horsepower curve.

The comparison of power consumption at the various loads is presented in Tables I to III inclusive. Thus, the saving obtained through the use of an 1800-rpm variable-speed unit instead of a 3600-rpm constant-speed pump is only 120,500 kwhr, or about $600 per year—remarkably little.

In order to complete this evaluation, it was necessary to establish comparative unit costs for the two combinations—including control costs. Such a comparison is shown in Table IV. It should be noted that the cost of the 1800-rpm unit would have been somewhat lower had it been possible to use the same size motor as at 3600 rpm. The change in motor size, however, is quite typical of the effect of the lower efficiency obtainable at the lower speed.

Finally, Table V presents the comparative total costs of the two installations. Two complete units have been included to provide for standby and the excess power costs capitalized at 15 per cent.

Constant-Speed Operation Wins

It will be seen that the total is definitely in favor of 3600-rpm, constant-speed operation. It is

Table IV—Comparison of unit costs

	3600 rpm constant speed	1800 rpm variable speed
Pump	$9,500	$13,000
Motor	4,898	3,873
Controls	565	1,940
Total	$14,963	$18,813

Table V—Comparative total costs

	3600 rpm constant speed	1800 rpm variable speed
Original Cost of two units	$29,926	$37,626
Excess power costs capitalized at 15%	4,017	0
	$33,943	$37,626

true that the difference is not extremely great. However, it should be noted that step controllers for slip-ring motors cannot hit operating conditions right on the nose, therefore the actual power savings are a little less than shown. Furthermore, if we were to take into consideration the fact that throttling of the excess pressure in the case of constant-speed operation is not entirely wasteful, as pressure energy is recovered in the feedwater in the form of heat, with an efficiency of the same order of magnitude as the efficiency of the power plant, the balance would swing even more towards constant speed operation.

Table VI—Comparison of unit costs for a 400-gpm, 500psi installation

	3600 rpm Constant Speed	1800 rpm Variable Speed
Pump	$1535	$3145
Motor	1345	1401
Controls	204	877
TOTAL	$3084	$5423

Table VII—Comparative total costs for installation in Table VI

	3600 rpm Constant Speed	1800 rpm Variable Speed
Original cost of two units	$6168	$10,846
Excess power costs capitalized at 15%	1025	0
TOTAL	$7193	$10,846

Another Analysis for Lower Pressures

Tables VI and VII illustrate the same effect applied to a lower-pressure installation. It was assumed that the boiler feed pump in question was designed for 400 gpm and 500 psi net pressure and that the subdivision of the yearly load duplicated that of the first example.

Author's Conclusions

It is obvious that the relationship of the three installations will not always be maintained in exactly the same ratio as in the two examples shown. The actual ratio will depend to a great extent on the exact nature of the plant load, because operation for very long periods of time at greatly reduced loads will reduce the advantage of constant-speed operation to a certain extent. The fact remains, however, that until reliable and less expensive 3600-rpm slip-ring motors or hydraulic couplings are made available, variable-speed operation of motor-driven boiler feed pumps does not pay the dividends it appears to promise. On the contrary, such operation may actually increase the combined installation and operating cost by as much as 10 to 50 per cent, depending upon the actual details of the installation.

SAVING OF NEARLY 35 tons of steel was made recently in the construction of a Westinghouse 6000-kw motor-generator set. Instead of the usual construction consisting of two 3000-kw units, the machine was made up of three 2000-kw units. Operation at 505 rpm instead of 352 rpm was thereby possible. At the higher speed an 85,000-lb flywheel provides the same stored energy as the 154,000-lb flywheel does at 352 rpm. Besides the saving in the flywheel, the smaller, higher speed generators require less copper, steel and other critical material.

AN INTERESTING CASE of increased production for the war effort through installation of capacitors was recently reported. The plant's transformers were operating at 85 C (185 deg F) and action of some kind was imperative. Westinghouse engineers who supervised the installation of capacitors, point out that the expense was not justified on the basis of power factor alone. However, considering the loss of production necessary to install additional power-handling facilities by the usual means, the capacitors proved by far the best solution for the problem.

Dust Collectors of Non-Critical Material

As a result of the shortage of steel, in April, 1942, WPB issued directives recommending the omission of all internal parts of fly ash collecting equipments in land installations. Since equipment of this character was essential in many industries, the Prat-Daniel Corp. immediately began a study to find means of substituting other materials for steel ordinarily used in the construction of dust collecting equipment. In this article which is based upon a talk on the subject by Mr. Whiton before the ASME on November 15, he gives the results of these studies and describes the development of new types of dust collecting equipment made of ceramic materials

By LOUIS C. WHITON
President, Prat-Daniel Corp., East Port Chester, Conn.

AS A RESULT of the critical situation with respect to steel during the present war, certain types of apparatus, which had been determined by good engineering practice as a necessary part of industrial operations, had to be eliminated wherever it was possible. Apparatus for the collection of dust is, of course, essential in many industrial operations, and it has rapidly become an integral part of all modern power plants. It is true that in previous years dust was not removed from flue gases, and it was hoped, therefore, that it would not be necessary to remove dust from such sources during the war period, thus economizing the steel necessary for the building of such dust collectors. This did not prove to be entirely true however.

Fig. 1. The new ceramic tube

It is interesting to note that in April, 1942, the War Production Board issued directives recommending the omission of all internal parts of fly ash collecting equipment in land boiler installations for the duration of the Emergency, for the purpose of economizing in the use of critical steel. This apparently was not capable of being followed completely because it was evident that there were various war plant operations which required clean atmosphere in the neighborhood of such plants, and imperative for the protection of the plant equipment and products, from injury due to fly ash returning to the plant by eddy currents in the atmosphere and reversal of wind direction.

A questionnaire was sent out by the writer's company to various war plants, to learn whether it was considered that dust collectors were essential for the operation of such plants. A large number of replies were received, over 90 per cent of which concluded that such dust collectors were necessary.

The amount of steel used in a dust collector varies considerably with the type of collector. The three mechanical types are:

1. Apparatus used in connection with a fan as part thereof.
2. Apparatus of a multicyclone type, consisting in a number of cyclones from 2 ft to 5 ft in diam.
3. The tubular type, consisting in a large number of small centrifugal tubes about 6 in. in diam.

A study was started immediately upon receipt of the directive from the War Production Board, and at the suggestion of that Board, to find means of substituting other material than steel in connection with this type of apparatus. It was evident from the start that the approach should be on the use of ceramic material, since the supply of raw product was unlimited, and it was probable that it would never be considered a critical product.

The writer's company manufactures all three types of dust collectors mentioned above, but the first type, where the apparatus was combined with the fan, was discarded as a possibility for the application of ceramicware in place of steel, since the parts would be relatively large, and the ceramic manufacturers did not feel that this was commercially feasible to manufacture with their material.

The multicyclone type was also discarded for the same reason, and the application was, therefore, determined to be most practical when using small diameter tubes, since the units could be made with a minimum of joints, and the type of manufacture was similar to that which has been practiced for many years by manufacturers of ceramicware, namely pipes and tiles.

Figure 3 shows a steel design of one tube of a tubular type of centrifugal dust collector. The steel tubes used were 6⅜ in. in diam for the main centrifugal tube, and 4½ in. in diam for the central or gas outlet tube. The inlets to the tubes for the gas were composed of heavy steel plate welded to an upper and lower disc. Each tube, depending upon the operating conditions, handles in the neighborhood of 250 to 300 cfm of gas, and the tubes are placed normally between tube sheets in sections, each section containing approximately 50 tubes. The gas enters the main section

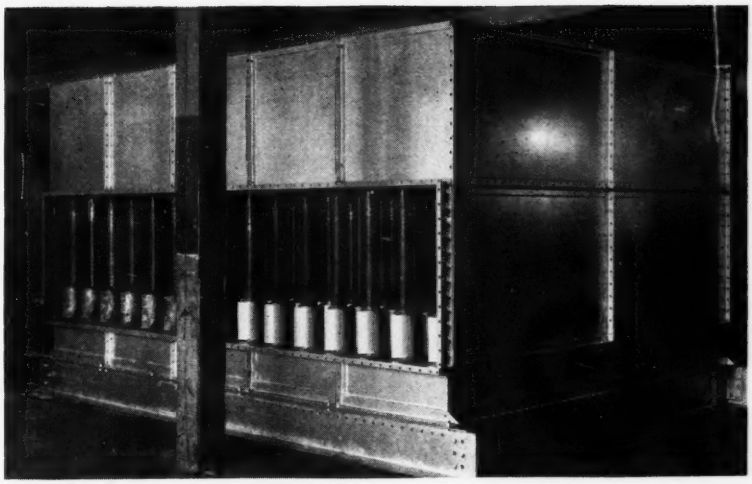


Fig. 2. Approximately 50 tubes are joined at their flanges to form the dust collector

between the two tube sheets, is rotated within the tube after it enters the flared inlets, thus precipitating the dust by centrifugal force, and the clean gas issues through the 4½-in. tube to a point above the upper tube sheet, whence it passes to the fan or to the atmosphere.

In general accordance with the original directive of the War Production Board, the problem was studied so as to utilize ceramic tubes set in steel tube sheets. A subsequent request on the part of the War Production Board to save in the use of steel, indicated the advisability of using non-priority material throughout, and therefore the final design consisted of the following:

A. Fire clay ceramic tubes.

B. Reinforced concrete tube sheets.

C. Brick side walls or reinforced concrete side walls.

Our engineers set up definite specifications to cover a ceramic tube that would meet the following conditions:

1. High dust collecting efficiency.
2. Resist erosion and corrosion.
3. Withstand the shock of rapid temperature changes.
4. Withstand fluctuating temperatures up to, and sustained at or above 600 F.
5. A design that could be manufactured by existing clay working plants and machinery when supplied with special dies.
6. A design, the component parts of which, may be easily assembled in the field.
7. Produce a ceramic tube that may be used equally well in either a steel casing or a non-priority materials housing or casing.
8. A ceramic tube must meet specifications 1 to 7 inclusive and be sufficiently rugged and sturdy to withstand the hazard of handling, transportation, and erecting, with a minimum of breakage.

To produce ceramic tubes that would meet these specifications required a careful study of the properties and characteristics of various fire clays, bonding clays, and other aggregates.

It was soon discovered that we were pioneering in the production of a ceramic product that had no parallel in refractory ceramics. Our consulting engineer secured the assistance of high class ceramic technicians who have had a well seasoned experience in manufacturing refractory ceramic specialties —the Prat-Daniel Ceramic Tubular Dust Collector is the successful conclusion of the combined efforts of those engineers and technicians assisted by the interested cooperation of the operating personnel of the ceramic manufacturers.

The Ceramic Tube

The lower portion of the tube shown in Fig. 1 consists of a 6½-in. tile with a flanged top, in which has been impressed recesses for holding the wings or flared inlets to the tube. These wings are a heavy curved tile of a special form required for this apparatus, and the tile may be made as thick and sturdy as required, since it is the internal diameter that matters. This is then capped by a companion flange, identical with the flange on the lower tube, and containing the same recesses, into which the flared inlet wings are fitted. The central 4½-in. tube is similar in shape to standard clay tiles, and this may be extended upward to any required distance by additional tubes.

The problem then arose as to the method of handling such dust collecting units in the field. A special cement was developed by the tile manufacturer, composed primarily of the same material from which the tubes are made, which is used to cement the tiles together in a jig. Its chemical reaction starts in 25 min, and when the tube is removed from the jig, it can be handled normally without any of its parts coming apart. The strength is indicated by the fact that aside from the weight of the tube itself, which is practically 60 lb, it required an additional weight of 115 lb on the bottom of the tube to pull any of the joints apart when the tube was held from its upper end.

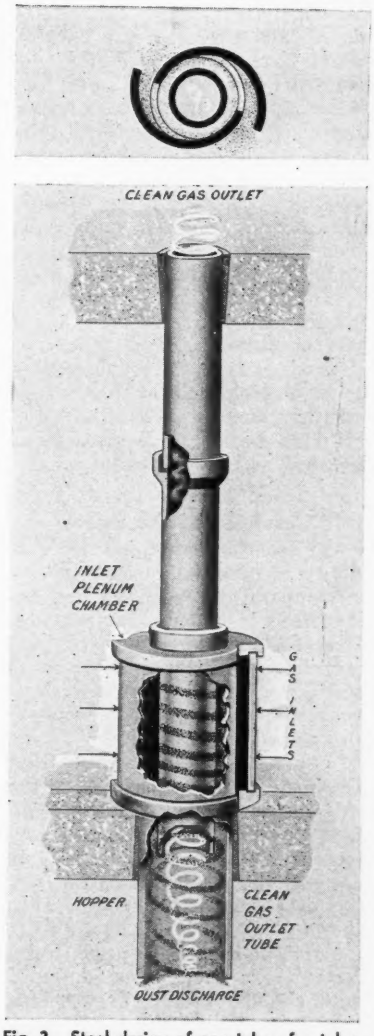


Fig. 3. Steel design of one tube of a tubular type centrifugal dust collector

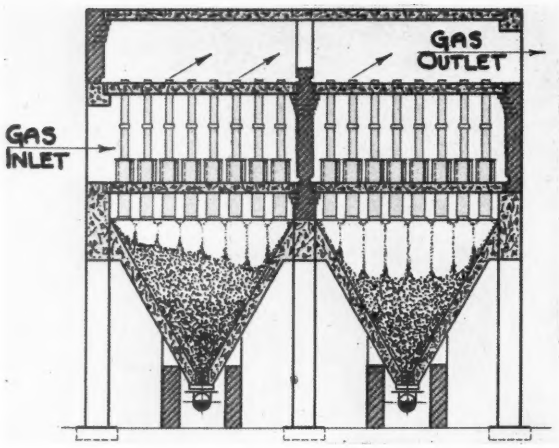


Fig. 4. The single deck arrangement requires more area with the ceramic tube than with steel but space can be saved by using the double deck arrangement shown in Fig. 5

Such tubes are shipped in knocked-down condition, in carefully prepared crates, and it has been found in practice that the breakage is an extremely small percentage. These tubes are then rapidly set up in the jig at the site of the installation, which is then removed, and the tubes are allowed to set 24 hr. They can then be handled by workmen without fear of having their parts separate, and they can be set in either steel tube sheets, to which they are cemented with the same material, or into concrete tube sheets for the ceramic unit. The 4½-in. gas outlet tube is arranged with a slip joint to allow for expansion.

The specifications for the manufacture of the tube require that it have a coefficient of expansion of approximately .000005, and that it be capable of withstanding a temperature range from 0 F to 600 F within a period of 2 hr without fracture due to expansion or any other reason.

Concrete as Tube Sheets

In order to determine the suitability of concrete for tube sheets in temperatures such as are encountered in boiler plant practice, a careful study was made of past experience in this use. Of course it was known that it has proved satisfactory to use concrete for walls of electrostatic dust collectors.

John L. Graham, Consulting Engineer, who is a specialist in the use of concrete and ceramics, with many years' experience on the subject, was employed to investigate not only the tube material, but also the use of concrete for the tube sheets.

An installation at Tupper Lake, New York, which was equipped with six 400 hp Sterling boilers, had been built with such reinforced concrete flues in 1916 and 1917. The smoke flue at that plant is 88 ft long, 7 ft wide on the interior, and 12 ft deep. The reinforced concrete slab floor is 6 in., and the roof is 5 in. in thickness. That plant has been in continuous operation, therefore, for approximately 25 yr, and G. P. Hull, the president, states that to date no repairs of any kind have been made on this flue.

After a careful observation of the above described use of concrete at high temperatures, the writer's company felt that it was entirely feasible to utilize this type of construction for the tube sheets of a tubular dust collector, since it was evident that it would be unusual that the dust collector would be subjected to such variations in temperature and such high temperatures as had been observed at the plant mentioned above had been in operation for more than 20 yr.

Further investigation was made with one of the large cement manufacturers, who reported as follows:

1. Heavier sections of concrete are more heat resistant than thin sections.

2. A small amount of dehydration occurs on the surface when the concrete is in contact with flame, and the surface skin thus produced is a better insulator than normal concrete, retarding dehydration at a greater depth.

3. Concrete cured for long periods is more heat resistant than concrete which has been cured for relatively shorter periods. 28 day curing or drying out is preferred.

4. Limestone or blast furnace slag aggregates give greater resistance than do natural siliceous aggregates. Lime carbonate in limestone acts as an insulator.

5. Crushed fire brick used to replace part of the aggregate materials produce good results when concrete is in direct contact with flame.

6. Special Portland cements do not show any advantage over normal Portland cements.

7. The baffle walls in cement kilns are frequently constructed of concrete, and in the plant of the engineer reporting it is reported that even at tempera-

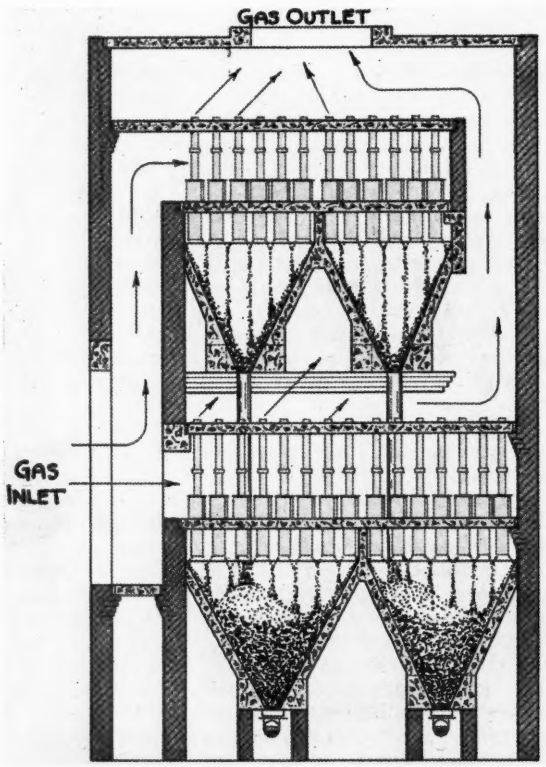


Fig. 5. The double deck arrangement saves space and forms a convenient support for induced fan and stack

tures as high as 1400 F many months' use can be expected. These baffle walls are constructed of normal Portland cement and slag aggregate.

Specifications for the reinforced concrete are extremely strict, and follow closely the specifications used in the construction of the concrete tops for flues installed 20 yr previously and still in operation. These call for the use of the best grade of American Portland cement, which must be fresh. The concrete must withstand temperature rises from 0 F to 600 F over a period of 2 hr. The sand used must be hard, sharp crystal, such as disintegrated or crushed red or black granite. Specifications are given also as to the fineness of the sand, which also must be entirely free of loam, silt, organic matter, and particularly from tannic acid.

For the crushed stone or granite used in the mix, only hard granite, hard limestone, dolomite, or trap-rock may be used. Special instructions are given as to the exact sizing of the crushed stone used in the aggregate. The degree of mixture is important. In 96 lb of the Portland cement, exactly 2½ cu ft of sand and 3½ cu ft of crushed rock is used.

Even transportation from the mixer to the job must be done with care, so as to not disturb the homogeneous condition of the concrete mass. Consequently the use of chutes between the mixers and forms is not acceptable.

From the above it will be seen that this is not an ordinary cementing operation of mixing cement, but one requiring great care and exactitude, and results, as noted above, in the remarkable ability of such cement to withstand high temperatures without damage.

As an additional protection to the cement itself, a layer of fire clay may be flowed over the top of the cement tube sheet after the tubes have been installed therein.

Space Conditions

The space required for the ceramic type of dust collector, if arranged in single deck, is greater than for the steel tubular dust collector. This is due to the fact that the exterior dimensions of the tube are greater, to allow for the greater thickness of the ceramic tube over the steel tube, and the exterior walls are thicker than steel. In other words, the tubes cannot be placed as close together as is possible with the steel tubing. This may be overcome from the standpoint of area occupied, by utilizing the double deck arrangement shown in Fig. 5.

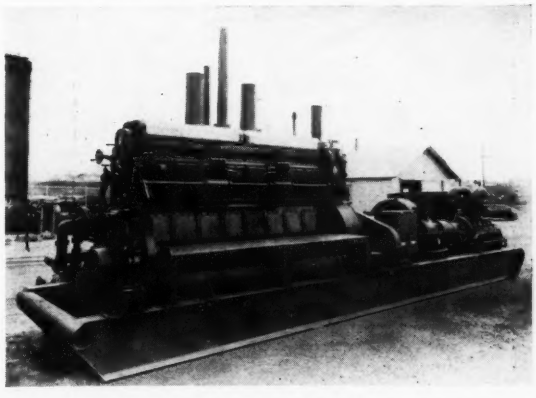
The double decked arrangement, with its greater height, forms convenient support for the induced draft fan.

The actual weight of each tube, is approximately the same as the steel tube.

Careful studies have been made of the efficiencies of the ceramic apparatus as compared to the steel apparatus, and no differences have been indicated.

Gas Engine Converted for Pumping to Self-Contained Diesel

A CLEVER CONVERSION and adaptation of a modern, gas-fueled, stationary type engine to a portable Diesel power unit complete for field service, was recently worked out by engineers of a major pipe line company of Tulsa, Oklahoma. This large portable Diesel unit answers a critical need by supplying convenient temporary pumping service for transporting crude oil through the trunk line to quickly provide an increase from 30,000 to 40,000 bbl per day, and can also be used for transporting crude oil from new wells through temporary feeder lines to main trunk lines, thus replacing several engines of less capacity. It can also be used as a temporary unit in the event of failure of a trunk line unit.



How large gas engine and auxiliaries, converted to Diesel operation, are mounted on I-beams to form self-contained, portable pumping unit

The complete, heavy-duty gas unit, one of six Cooper-Bessemer Type EN, 8 cylinder stationary gas engines previously installed at a pumping station, was quickly converted to oil fuel operation. Mounted on a base of 18-in. I-beams, complete with all auxiliary equipment as shown in the accompanying photograph, it can be quickly transported to new field locations and placed immediately in service. Once it is placed in the desired position, the procedure consists merely of making the crude oil intake and discharge connections. Then the unit is ready to handle at least 700 bbl of crude per hr at 700 psi. A direct-current generator is fitted at the flywheel and of the engine to furnish power for lighting.

The heat exchanger, mounted along the length of the base skid is connected from the discharge of the crude oil pump, to the crude oil feeder line, the oil acting as the cooling medium for the exchange cooling the jacket water.

To complete this self-contained unit, are two Nugent waste pack oil filters, for filtering fuel oil and one for filtering lube oil, and two fabricated boxes, one for tools and spare parts, the other for storage of renewal waste packs, wiping rags and other essential supplies.

THE A. C. CALCULATING BOARD at Westinghouse is constantly engaged these days. The need for coordinating power systems throughout the country, together with the need to squeeze every available kilowatt from existing facilities to speed the war job, brings engineers from all parts of the country to East Pittsburgh to work out their problems.

POWER for a new powder plant in the South recently gave utility engineers a temporary headache. WPB wanted the load to be handled without purchase of any new major equipment. The problem was solved through installation of seven Westinghouse hood-type blowers which gave the station 25 per cent increased capacity, enough to supply the powder plant.

Joint Fuels Conference

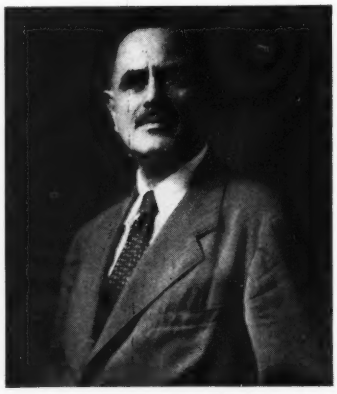
Seventh Annual Meeting of the ASME Fuels Division and the AIME Coal Division placed emphasis on research as principal means of economizing on fuel. Better mine management, producer gas making, coal carbonization problems, colloidal fuel and trends in fuels were also discussed at this two-day meeting

MOST CERTAINLY the coincidence of the thousands of coal miners going out on strike and the holding of the Seventh Annual Joint Fuels Conference was not planned that way, for the date of this meeting, October 28 and 29, and the place, Pittsburgh, Pa., were chosen about a year ago. No doubt, however, the coal mining situation had an influence on the attendance which was more than 500 and this registration included men responsible for supplying the nation with coal; engineers who burn fuel for productive purposes in industry, combustion equipment manufacturers and research specialists engaged by the Government and other institutions.

Selling research to the bituminous coal industry in the past met with many discouragements but, said E. R. Kaiser of the Battelle Memorial Institute, "the bituminous coal industry is rapidly becoming cognizant of the necessity for industry-sponsored research to develop and further the use of coal as a fuel and as a chemical raw material." Among the causes given for this interest were the competition with other fuels, waste that prevails in the use of coal, and the desire to retain a high level of coal production through the development of a more desirable fuel and more convenient and economical coal burning equipment.

Bituminous Coal Research, Inc., the research agency through which the industry is working, has formulated a five-year program which is planned to improve the use of coal in residential and industrial heating, metallurgical operations, carbonization, gasification and railroad locomotives. Other phases of the work to be carried on will deal with the production of organic chemicals, fundamentals of combustion and ash behavior, and coal mining, preparation and transportation. The cooperation of equipment manufacturers is being sought in this work.

The program, it is explained, is largely a diagnosis of the problems and needs that stand in the path of coal's progress. In this program, power engineers may look for information on how to improve and regulate stokers of various types to the end that coal and ash characteristics will be less critical and that smoke, fly ash, and uncontrolled slagging will not occur. The effect of coal size and movement of coal in the fuel bed will be studied, also combustion rates, heat absorption, furnace temperatures, and recirculation of flue gases. Internal combustion engines and gas turbines which derive their power from coal will be given consideration in this research program.



Henry Kreisinger, recipient of Percy Nicholls award

In the domestic stoker field, R. J. Helfinstine of the Illinois State Geological Survey Division, described in detail an investigation he is conducting on the correlation of domestic stoker performance with laboratory tests and types of fuel. Standard tests have been adopted for determining the quality of fuels but no definite procedure for rating the performance of coal in a domestic stoker has been adopted. It is to the determination of the amount of heat obtained from a pound of coal that Mr. Helfinstine is directing his attention.

Fundamentally, the training of workmen in one industry differs but little from the principles successfully employed in another. G. Ralph Spindler of West Virginia University in his paper on Modern Training for Miners at the Face, emphasized that it is essential to make a logical approach to the problem by outlining specifically the results to be expected, the persons or groups to receive training, the training to be given each group and where, how, when and by whom the training is to be done. In the problem under discussion he made a general classification of the training groups as follows: (1) Supervisory employes; (2) Mechanical and electrical maintenance; (3) Crew workers—job training; and (4) Technical and semi-technical apprentice.

In his opinion men with good engineering training in mining and other technical fields are recognized to be essential to continue technological advancement and the future health of the industry and proper attention should be given to maintaining or securing an adequate supply.

Considering the postwar problems that are about to confront the industry, Robert M. Weidenhammer, president of the Cosgrove Coal Co., advocates the formulation of a national fuel policy by both the coal and oil industries, a policy which would benefit both industries. "For years before the war," he stated, "coal had the reputation of being a sick industry. Currently it is operating at peak production and succeeding pretty well in keeping out of the red. But it will have a relapse as soon as the war ends unless (1) working capital can be built up; (2) it gets the support of the people and Congress; and (3) a truly long-range national fuel policy is formulated."

He did not attempt to recommend any particular permanent policy but discussed briefly four courses that might be taken by Congress: (1) permanent nationalization of the mines; (2) complete status of laissez-faire; (3) self-regulation: and (4) federal regulation. The national fuel problem was stated as how best and cheapest to supply the American people with heat and power.

Declaring that producer gas is the cheapest artificial fuel per Btu that can be made from solid fuel, D. B. Hendryx of Harbison-Walker Refractories Co., proceeded to prove his statement by presenting operating cost data. He pointed out that producer gas is made from coal or coke and combustible in the solid fuel is

(*Continued on Page* 122)

The PRACTICAL ENGINEER *and* ELECTRICIAN

ANDREW W. KRAMER, EDITOR

Stratosphere Refrigeration

Refrigerating men who keep up with all that is going on in the industry and who know all the latest answers probably know this one but it was a new idea to us and there may be others to whom it is new. We found it in a discussion by Professor Sleeter Bull of the University of Illinois on post-war problems of the locker (refrigerating) industry. It has to do with the effect of aviation upon methods of handling frozen foods.

After the war is over, we will have thousands of planes, thousands of pilots, and millions of air-minded people. A young pilot returning from Europe after a year as pilot on a Flying Fortress tells us that the temperature at 20,000 ft is —45 F. With a speed of 250 miles an hour and a capacity of 30 tons he sees no reason why one of our flying boxcars can't pick up a load of packaged, fresh strawberries at Hammond, La., and deliver FROZEN strawberries in Boston a few hours later; then pick up a load of fresh fish and deliver frozen fish in Chicago; then a cargo of fresh beef and land it in New Orleans ready for the consumer's home freezer.

Naturally, the comparative costs of mechanical freezing and rail or truck transportation of the frozen product must be compared with the freezing costs of stratosphere freezing and transportation. The pilot said he knew that it costs $1.38½ a hundred to ship a car of frozen fish from Boston to Champaign, Ill., approximately 1000 miles as the crow or one of our transport planes flies. He did not know the cost of quick freezing however.

In an address before the Royal Aeronautical Society in London, in May of this year, Edward Warner, vice chairman of the Civil Aeronautics Board (U. S.) in discussing the cost of carrying cargo by plane said that cargo planes can carry un-mixed freight at a cruising speed of 200 miles per hour for about 10 cents per ton mile if loaded to capacity or for about 14 cents per ton mile if loaded to 65 or 70 per cent capacity. On the latter basis it would cost $7.00 a hundred to ship frozen fish from Boston to Champaign, as compared to $1.38 via rail. But the freezing would cost nothing.

CONTENTS

Million Dollar Plants vs. $1500 Men 98
By Andrew W. Kramer

Indicator Diagrams 100
By Denard Lee Gusler

Determining Compactness of Coal 102
By G. C. Daniels

Steel Wire for Electrical Conductors 103
By S. O. Miller

Refrigerating Fundamentals 105
By Harold Bradley

Power and Industrial Plant Maintenance 107
By M. A. Jensen

Practical Hints and Kinks 108
Old-Time Feedwater Control
By Thomas M. Street
Special Scraper from Old Hack Saw Blade
By Wm. O. Sinn
Overcoming Alinement Headache
By William Otto

Letters and Comments 110
Where Should Idler Pulleys Be Located?
The Egg-Shell Scale Episode

Questions and Answers 112
How Is a Depressed-Zero D-C Voltmeter Made and Used?
How Much Heat Does Pipe Insulation Save?
How Improve Draft with This Chimney?
Who Has a Work Schedule for a 6-Day Week?
Why Does the Flow Meter Lag?
Why the Difference in pH in These Two Boilers?
How De-Mud Reservoir without Shutdown?
Why Electricians Chew Their Fingernails
Where Does the Engine Get All the Btu's?

Characteristics and Applications of Polyphase AC Motors ..120

A Section of Power Plant Engineering Devoted to
PLANT OPERATION AND MAINTENANCE

Technical Publishing Company
53 West Jackson Blvd., Chicago 4, Ill.

Million Dollar Plants vs. $1500 Men

By ANDREW W. KRAMER

IN A LETTER received a few days ago a subscriber informs us that he has an 800 hp boiler operating with a flue gas temperature of 580 F and with 6 to 7 per cent CO_2. He wants to know what his CO_2 should be. I answered this letter, as we do all such letters, telling him not only what his CO_2 should be but suggesting several things that may be responsible for his low CO_2. Incidentally, I referred him to Joe Hays' excellent book.

This letter is typical of many letters of a similar nature that we receive by the scores each year. Another one, about a week ago, was from a subscriber who wrote that he had been told by the subscription salesman who took his order that we would answer any question that he had. Well, he was taking us up; here was his question: He had a cylindrical heat exchanger in the boiler room of his plant that was not covered with insulation; how many Btu's would he save if he covered this heater with insulation? He did not indicate his steam pressure nor what the outside temperature was, nor what kind of insulation he had in mind, but I assumed values for these things and gave him what I thought was a fairly complete answer.

In a way these letters are rather pathetic. We are glad to answer them because when we do the men who ask the questions are always very grateful for the little advice we can give them, but it seems strange that men in charge of power plant equipment should have to ask such simple questions. After all, the information needed is all contained in handbooks and textbooks and it would seem reasonable that a man in need of such data would try to look it up himself. The point is, a man in charge of power plant equipment should know the anwers to such questions.

I do not blame the men for asking us the questions; they are merely trying to find the answers in the only way that seems open to them, but I do blame the owners of the plants in which these men work for not having enough interest in their power plants or boiler rooms to hire capable men as engineers or to train those they do employ so that they can handle their jobs properly.

Power plant equipment these days is not cheap. Even a small plant will represent an investment of anywhere between $50,000 and a half million dollars. A moderate size boiler will run $75,000 to $100,000. This is not chicken feed in any man's language, yet owners of factories will build a power plant costing a half million dollars and then proceed to hire the cheapest "help" they can get to run it.

Only a short time ago an experienced engineer came in to see whether I could help him in getting a new job. He was chief engineer of a large and modern office building in Chicago and had under his care the boiler room, all heating and ventilating equipment, all electrical apparatus, including the elevators, etc. He was a first class, licensed man, had been on his present job for many years and he "knew his stuff." He was not the type of man who had to ask questions such as referred to above—he could answer them and many others far more complex and difficult. This man was making $4000 a year and he thought that he was worth $5000. He had asked his present employer for a raise but with no results, so he was trying to see whether he could not make a change for the better.

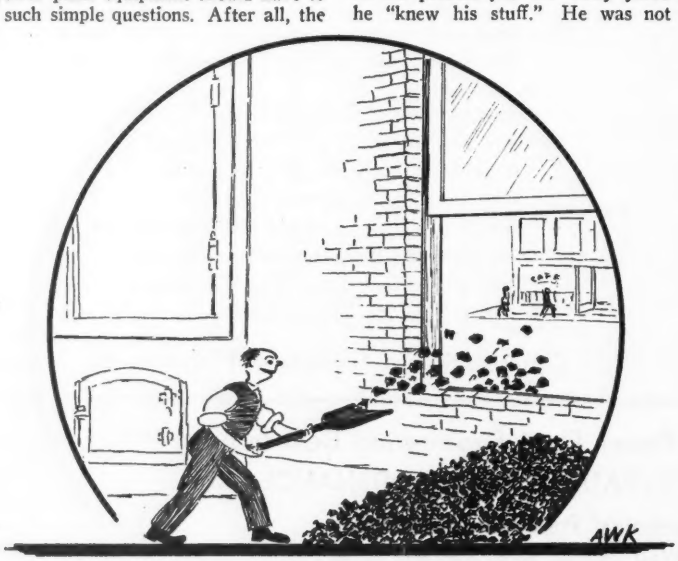
I could not help thinking of the difference between this man with his years of experience and his responsibilities and certain war plant workers I have seen during the past few years; workers who did nothing else than operate a single machine, a task which anybody with reasonable intelligence could learn in a few days' time. These war workers were dissatisfied with the miserly 70 to 80 and even 90 dollars a week they were getting — they thought they were being "gypped," as they put it.

True, the jobs of these war workers may vanish with the end of the war but the fact still remains that compared to the war workers, the chief engineer is vastly underpaid. A good waiter these days can make $5000 a year.

The point I want to stress here is not so much that my chief engineer acquaintance is underpaid but that because of this miserly attitude on the part of power plant owners toward their power plant employes, they are often getting inferior men — inferior from the standpoint of training.

It would seem only good logic, certainly good business, that business men, spending hundreds of thousands of dollars for the most modern power plant equipment, would take every reasonable precaution to safeguard this equipment and to have it operated efficiently by capable engineers rather than by good-grade janitors. That is all a good many so-called power plant operators are. They can shovel coal or keep a stoker running but they know little about steam engineering.

On another page of this issue our old friend, Bill Heiwig, presents an interesting account of what he found in the boiler plant of a company making pharmaceutical supplies. The owner was very much surprised to find that the trouble they had been having was due to an unusual and entirely unnecessary accumulation of scale, but if he had ever taken the trouble to find out how much his engineer knew or rather how much he did not know about running a power plant he need never have had any trouble. Bill Heiwig does not say, if he knew at all, what the engineer in this plant was making but the chances are if he was making $35.00 a week he was delivering about as much as he was worth. The manager was probably getting about what he was paying for but it is quite possible that if he had hired a man worth (to himself) twice what the engineer was actually getting, he would have delivered three or four times his salary in more efficient operation. In the case referred to above, about the engineer with the bare heater, he could save almost a ton of coal a day merely by



It would be cheaper just to shovel the coal out the window

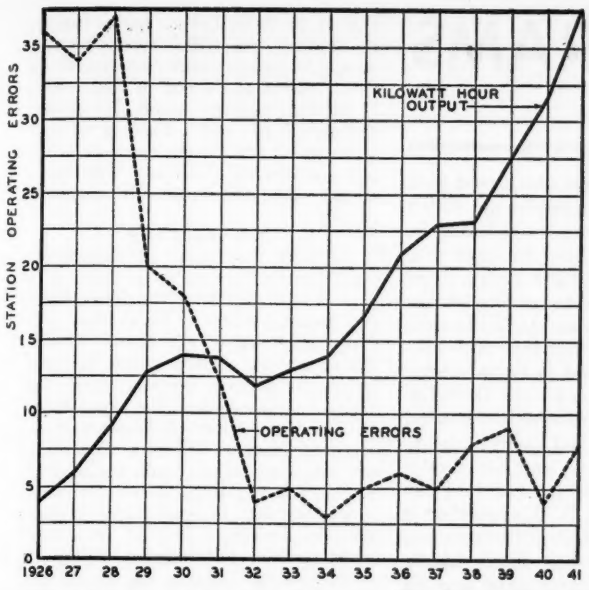


Chart showing how the number of operating errors decreased when the Philadelphia Electric Company started a program for the selection and training of substation operators in 1928

covering his heater properly. Evidently he was thinking of doing this but how long the waste had been going on he did not say. And, it is quite probable that if this loss from radiation existed, other losses also occurred. In the other case cited, where the boiler was being run with 6 per cent CO_2, the furnace efficiency was 50 per cent against a possible 70 per cent or higher. A high-grade moron could figure what this means in coal over a period of a month or a year. It would be cheaper to just shovel the coal out of the window.

Again I want to stress the fact that I am not blaming the operators so much as the plant owners. If they insist on hiring cheap operators, they can expect only cheap performance.

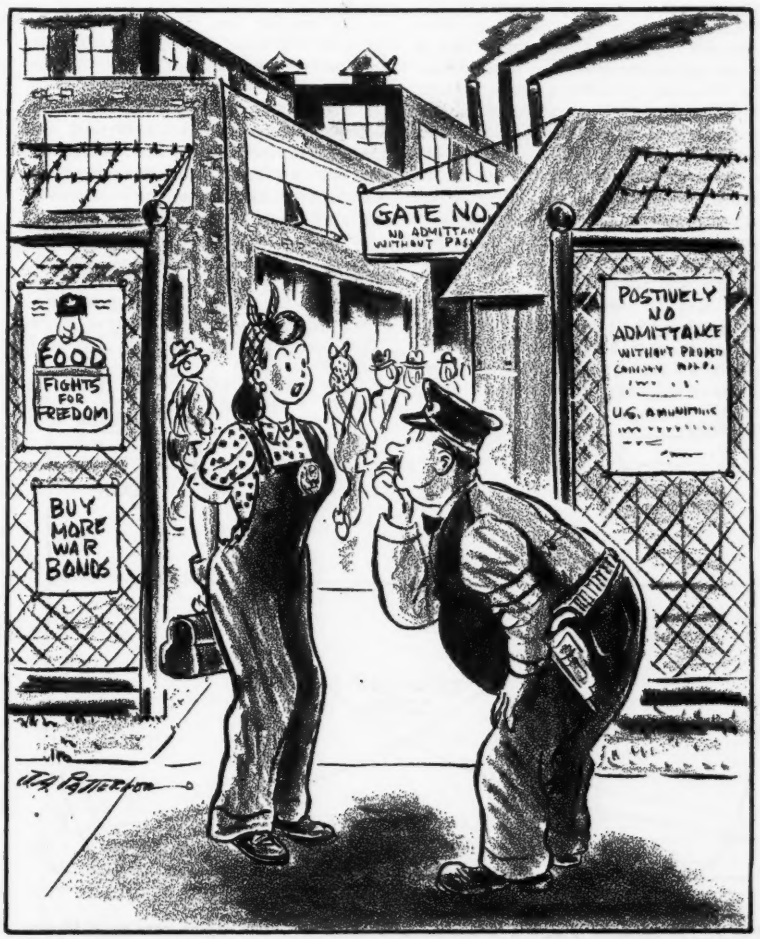
Among some of the good things which may develop as a consequence of the war is a better appreciation on the part of plant owners of the value of trained power plant personnel. The scarcity of manpower in all fields has made it necessary for many plant owners to hire help that had little or no experience at all in power plant work. Even the most indifferent owner or manager can understand that a power plant operator must have some experience or training and so by sheer force of necessity, training programs have been started.

The large central stations have had training programs of this kind for many years and have found them extremely worth while and effective. Just take a look at the accompanying chart which was published in our September issue in the article by N. E. Funk on Employee Training in Industry. As Mr. Funk pointed out, at the Philadelphia Electric Co. a program to select and train substation operators was started in 1928. Note how markedly the operating errors decreased from 1928 to 1932 when the program was put into effect. Note also that despite greatly increased kwhr output after that the operating errors have been kept at a very low point.

The Philadelphia Electric Co. started its training program long before the war, as did many other large operating companies, but many have inaugurated them only since the war began to tighten the manpower situation. It is safe to predict that these wartime training programs will not be discontinued when the war ends. They will have been found so valuable and effective that they will be continued and kept as a permanent part of the power department. The owners of these companies will wonder how they ever operated without them.

Unfortunately there are still too few plants where these training programs have been organized. In very small organizations it is difficult to organize such programs but in such cases the men can be encouraged to attend classes in schools or colleges or to take correspondence courses. They can be given time off to do this and they can be provided with reference books and technical magazines.

In the past two decades there has been great development in the mechanical and electrical end of the power plant, millions and millions have been spent on high pressure, high efficiency power plants, but very little in comparison has been spent on the human side of these plants; in the development of the personnel to operate them. More attention to this aspect of power plant operation will save more coal and oil during the years to come than any slight increase in the thermal efficiency of our already high efficiency plants.



"Oh heavens, don't look at that—it's positively horrid of me!"

INDICATOR DIAGRAMS

By DENARD LEE GUSLER

On Page 104 of the October issue, one of our good readers who signed himself J. D. G., asked a question. He wanted to know where an engine got all the Btu's; his engine, apparently, was turning out more Btu's than it was taking in. Well, the answer was relatively simple but few questions that we have presented in the Q & A section in recent years have brought forth such a flood of comment. J. D. G.'s trouble was due largely to his failure to use the Mollier diagram. Among those who pondered over the question was Mr. Gusler, the author of this article on Indicator Diagrams. Mr. Gusler felt that the whole problem could be clarified by a more thorough analysis and so he set about proving the problem mathematically with a steam expansion curve. The adiabatic curve derived from the steam table pressure-volume relationship proved to be the simplest in that logarithms were not involved and quite accurate results were obtained. One thing led to another, however, and Mr. Gusler decided to work up a complete article dealing with the information that can be obtained from the indicator diagram. He feels that J. D. G.'s question is fully answered in his article and the information presented should enable any steam engine operator with a rudimentary knowledge of how to use steam tables to derive much useful information about his indicator card and his engine. Most operators know how to take an indicator card and how to adjust the valves of the engine correctly but that is as far as their knowledge goes in many cases. To those men, this article should be of interest and value

THE INDICATOR DIAGRAM has three important uses. The most important is its use for determining the Mean Effective Pressure (MEP) in the cylinder, and from that, the horsepower developed by the engine. It shows by its shape, whether the valves of the engine are properly set and discloses faults in the setting. The third use is in connection with the determination of the approximate amount of steam used by the engine per hp per hr. This is a discussion of the first and third uses.

It will be seen that the diagram, Fig. 1, traced by the pencil of the steam engine indicator, is a curve showing the relation of the pressure and the volume of the steam in the cylinder at all points of the stroke; for, the horizontal distance of any point on the diagram from the end of the diagram represents the distance of the piston from the end of its stroke, and therefore represents the volume of steam; and the vertical distance of the point from the atmospheric line represents the gage pressure of the steam in the cylinder at the corresponding position of the piston.

As the height of the diagram represents a force and the length of the diagram a distance, the area of the diagram represents the product of force and distance which, in turn, represents work. Thus, every indicator diagram is a work diagram, also.

The diagram Fig. 1, was drawn for a 30 in. by 48 in. Corliss engine running at 80 rpm, the initial steam pressure being 120 psi abs; back pressure 18 psi abs; pressure at the end of compression 75 psi abs; apparent cutoff, 1/5 stroke; clearance 3 per cent. Using a 60 indicator spring and letting one inch represent eight inches of stroke. Two inches on the scale of pressures represents 60 psi abs.

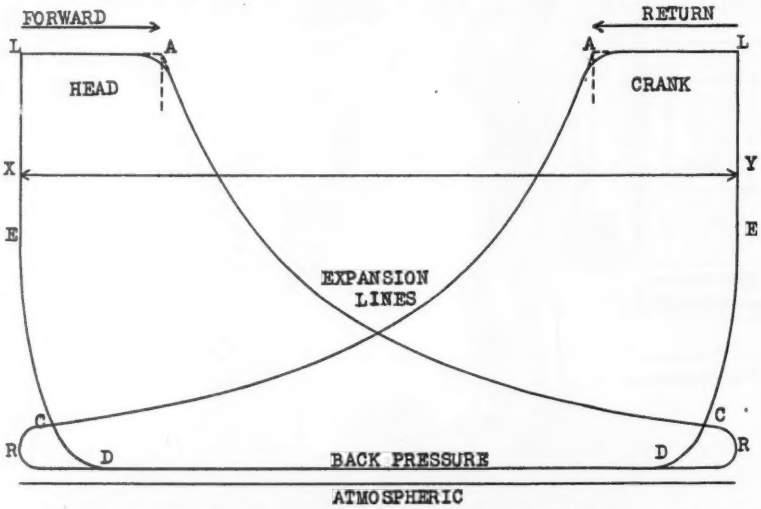


Fig. 1. The Indicator Diagram. Drawn for a 30 by 48-in. Corliss engine, running at 80 rpm, and an initial steam pressure of 120 psi and a back pressure of 18 psi. Apparent cutoff 1/5 stroke, clearance 3 per cent

Determining MEP

In order to calculate the horsepower developed in the engine cylinder it is necessary to determine the Mean Effective Pressure which is the average pressure (psi) urging the piston forward during an entire stroke in one direction, minus the average pressure (psi) that resists its movement in the same period.

The Mean Effective Pressure is determined from an indicator diagram in the following manner; take the diagram as shown in Fig. 2, and divide the atmospheric line into 14 equal parts. This is done by drawing a line XZ at a small angle to XY. Starting at X lay off fourteen equal distances Xa, ab, bc, etc., the end of the fourteenth distance being the point Z. Connect Z with Y, and from the other points a, b, c, etc., draw lines parallel to ZY, until they intersect XY. These points of intersection will divide the line XY into 14 equal spaces. The middle points of these spaces can then be located by direct measurement. From these middle points, ordinates are erected as at AB, CD, etc. Using the vertical scale of pressures the ordinates are now measured to determine the net pressure acting on the piston at that point in the stroke. Then the sum of these pressures is divided by 14 to give the MEP which is 45.8 psi for this diagram. The indicated hp (IHP) can be determined from the formula:

$$IHP = \frac{PLAN}{33{,}000}$$

P = MEP
L = Length of stroke in feet.
A = Area of piston in inches.
N = Number of strokes per minute.

Using the data presented for the afore-mentioned Corliss engine:

$$IHP = \frac{45.8 \times 4 \times 706.86 \times 160}{33{,}000} =$$

627.8 IHP

Determining Engine Efficiency

To determine the engine efficiency it is first necessary to find out how much steam is being used per IHP-HR. Referring to the diagram Fig. 3; A line ba is drawn, from the point which is just ahead of the point of release, to the compression curve. From the ends of the line ab, vertical lines am and bn are drawn to the vacuum line. The length ab is indicated by X and the length of the diagram by y. The point a, therefore, indicates by its distance from the clearance line, OY, the volume of steam in the cylinder just before release; and the point b, by its distance from the line OY, indicates the volume of steam under compression, at the same pressure as at a. The difference between these two, or the length X, therefore repre-

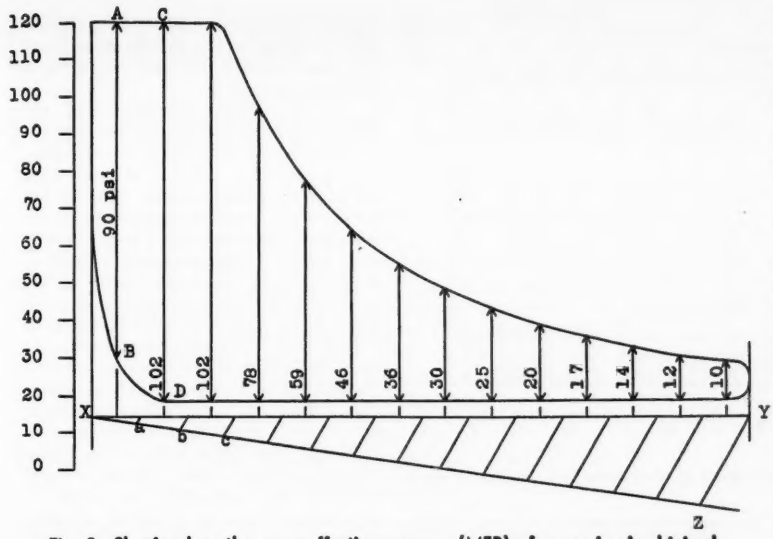


Fig. 2. Showing how the mean effective pressure (MEP) of an engine is obtained

sents, to the scale by which y represents the volume of the cylinder, the volume of steam used per stroke of the engine. If this volume, in cu ft, is multiplied by the weight of a cu ft of am, or bn, the product will be the weight of steam used per stroke. The formula for pounds of steam per IHP-HR is:

$$Q = \frac{60 \times LANw}{144y} \times \frac{33{,}000}{PLAN} = \frac{13{,}750Xw}{Py}$$

$$= \frac{13{,}750 \times 5.62 \times .0705}{45.8 \times 6} = 19.8 \text{ lb}$$

per IHP.

w = weight of one cu ft of steam at pressure am, which is 29 psi abs. Using this pressure w, is the reciprocal of the specific volume of steam at 29 psi abs as found from the steam tables.

$$w = \frac{1}{Vg} = \frac{1}{14.189} = .0705 \text{ lb}$$

Finding Steam Consumption

Finding the steam consumption from the diagram is an approximate method because it takes no account of the water formed by condensation of the steam by contact with the cylinder walls. With a single cylinder and early cutoff the loss due to cylinder condensation may be as much as 40 per cent of the steam while with a triple expansion engine and cutoff at middle of the stroke the loss may be 10 per cent. Formula for closely estimating the steam condensation in a cylinder can be found in any mechanical engineering handbook. Assuming for the purposes of this illustration that the loss amounts to 40 per cent we find that the corrected steam per IHP-HR is 27.72. Now the engine efficiency, with reference to IHP can be figured as follows:

$$EE = \frac{2545}{27.72\,(H1 - H2)}$$

H1 = Total heat of 1 lb of steam before throttle valve.

H2 = Heat of 1 lb of steam after isentropic expansion to pressure at exhaust.

The value of H1 is 1190.4 Btu and of H2 is 1050 Btu as found from the Mollier Diagram.

$$EE = \frac{2545}{27.72\,(1190.4 - 1050)} = 65.4$$

per cent.

Actual condition of admission and exhaust steam should be determined by use of a throttling calorimeter for accurate results.

The Mollier Diagram has shown a heat loss per pound of steam of 140.4 Btu whereas looking in the steam tables we find that steam at 120 psi abs contains 1190.4 Btu and at 18 psi abs 1154.2 Btu giving a difference of 36.2 Btu. Then according to the Mollier Diagram some of the steam has condensed and given up its latent heat of evaporation which has been converted into mechanical work. That this is true can be proved as follows; erect a vertical scale of pressures and a horizontal scale of volumes as shown in Fig. 4. Then lay off the volume of steam at 120 psi abs. Saturated steam is a vapor, in a state between that of a liquid and a perfect gas. Consequently in expanding it does not obey the law of a perfect gas but obeys laws that are applicable by use of higher mathematics. For all practical purposes the expansion may be assumed to follow a hyperbolic curve, the construction of which will be covered later.

The solid line curve Fig. 4, is a hyperbolic curve which shows the steam expanding according to the law, $pV = a$ constant. The broken line curve is constructed by using the volumes of the expanding steam given in the steam tables. This curve then shows the expansion of dry saturated steam adiabatically, that is, in a cylinder that is a non-conductor of heat, consequently all the heat lost is converted into mechanical work.

The average pressure of expansion is found to be 40.87 psi abs. The volume swept through by the piston is 22.17 — 3.728 = 18.442 cu ft. The work is $144pV = 144 \times 40.87 \times 18.442 = 108{,}526$ ft-lb, nearly. The heat change of steam expanding from 120 psi abs to 18 psi abs according to the steam tables was 36.2 Btu or $36.2 \times 778 = 28{,}163.6$ ft-lb.

The work done by the expanding steam is 108,526 ft-lb, while the steam during its expansion gives up 28,163.6 ft-lb. It is evident that work could not have been done by expansion of the steam alone. There remains 108,526 — 28,163.6 = 80,362.4 ft-lb of work that must have been obtained in some other manner. The only way in which this extra work can be accounted for is that a small amount of the steam condensed while expanding, and thus gave up its latent heat of evaporation. 80,362.4 ft-lb

$$= \frac{80{,}362.4}{778} = 103.29 \text{ Btu.}$$

The average pressure was 40.87 psi abs and the latent heat of steam at that pressure is 932.75 Btu. Hence $\frac{103.29}{932.75} = 0.117$, approxi-

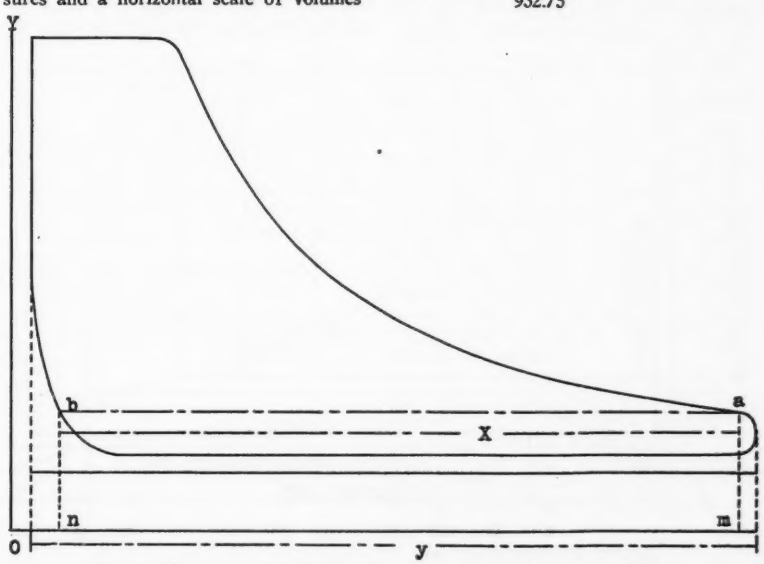


Fig. 3. Diagram used in determining steam consumption per IHP-HR

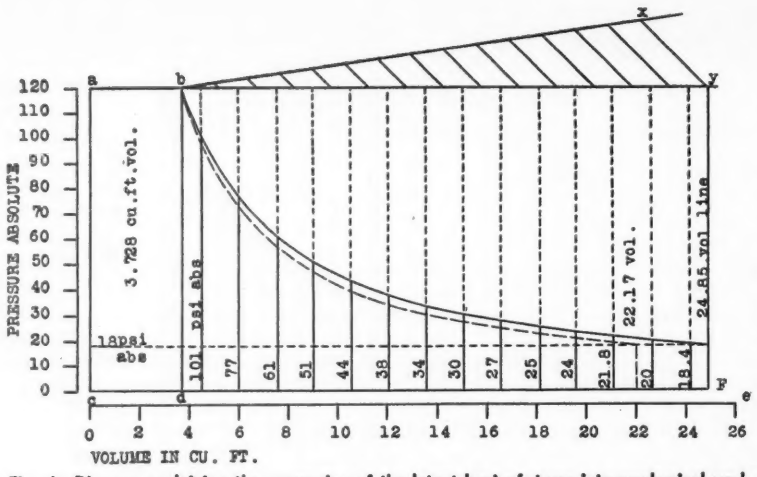


Fig. 4. Diagram explaining the conversion of the latent heat of steam into mechanical work

mately, must have condensed to furnish the extra foot pounds of work.

In other words, the condensation of steam, when expanding in a non-conducting cylinder, is not due in any way to the cylinder itself but is caused by the loss of that portion of the heat that is converted into work.

The expansion line on an indicator card, from the cutoff to pre-release, should be an adiabatic curve, that is a curve, as mentioned previously, which represents neither gain or loss in heat. As the curves on actual cards never follow the line it is a good plan to draw an adiabatic curve for reference or it is frequently desirable to draw the theoretical indicator card. To draw the curve accurately requires the use of complicated formula, but the expansion and compression curves correspond closely to the hyperbola. A simple graphical method for constructing the entire diagram is shown in Fig. 5.

The vacuum line JX, Fig. 5, is drawn to a length XY, Fig. 1. At a distance 3 per cent of the stroke, the clearance line OY, is erected to the height of the indicator diagram. (Actual) The point O is now connected to the point J. The line JV, is drawn to the same height as OY, the point V being the beginning of the forward motion of the piston. The point A', for this diagram, is established at a distance from V, 1/5 of stroke, and the horizontal line VA' is drawn and extended indefinitely. The point A' is the point of cutoff. Select any number of points A-B-C-D-E-F. Connect each of these points to O, and draw the line A'G, parallel to VJ. From the points where the radial lines cross A'G, draw horizontal lines and from the points A-B-C-D-E-F, drop vertical lines. Through the points where these two sets of lines meet, draw the curve a-b-c-d-e-f, which is an exact hyperbola ending at the point where the vertical line drawn from X is intersected. The back pressure line is shown parallel to and at a distance representing the absolute back pressure, from the vacuum line. The equilateral hyperbola for the compression curve is constructed similar to that for the expansion curve with the exception that the radial lines used in the construction terminate in a horizontal line m, drawn through the point at which compression ends. The point of cutoff, release, and beginning of exhaust are now rounded off and we have a complete diagram.

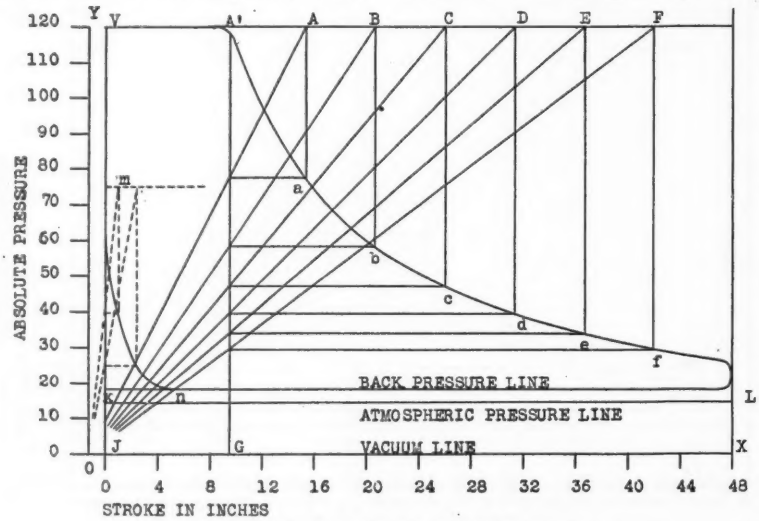


Fig. 5. Method of constructing an adiabatic curve

It will be found that the actual expansion line will fall below the theoretical curve at the first stages of expansion, and usually rises above it at some later point in the stroke. Steam entering the cylinder will condense somewhat, consequently its pressure falls more rapidly than due to expansion, until a point is reached where the temperature of the steam equals the temperature of the cylinder walls, and from thence the condensed steam will be re-evaporated, because the metal of the cylinder is hotter than the steam. Thus it will be understood, that the true expansion curve never equals the theoretical curve.

These conditions and the fact that the actual steam engine cylinder is never perfectly non-conducting, but made of metal that is a good conductor of heat, leads to great complications in the study of the action of the steam in the cylinder.

Incidentally, the steam tables under the title "Thermodynamic Properties of Steam," by Keenan & Keyes, can be purchased from John Wiley & Sons, Inc., of New York. Extra copies of the Mollier diagram may be obtained from the American Society of Mechanical Engineers also of New York.

Determining Compactness of Coal

By G. C. Daniels

Mechanical Engineer
The Commonwealth & Southern Corporation

In the storage of coal it is often desirable to know the degree of compactness of the storage pile. This is quite easily determined.

If the quantity of coal in the given pile is known, the compactness can be computed by determining the volume of the pile. Where the quantity of the coal in the pile is not known definitely, the amount of compactness can be determined by digging out a portion of the coal and determining the weight and the volume of the hole. This is very readily done when coal is compacted by means of a bulldozer since the coal will stand vertically on the sides of the hole so it is easily possible to dig a hole say 3 ft square by 2 or 3 ft deep. The dimension of such a hole with straight sides is readily obtained and this method is quite accurate. To determine the weight of loose coal, it is only necessary to weigh a box full of coal and determine the cubical contents of the box. The box should be large enough to get a representative sample of coal and I would suggest a box 2 ft cube. The loose weight of coal does not change very much nor is it very much affected by the coal size.

In storing and compacting coal by a bulldozer, care must be used not to attempt to compact sized coal, that is coal from which the fines have all been removed. Trying to compact coal of this character only makes it more liable to spontaneous combustion.

STEEL WIRE For Electrical Conductors

As a result of the difficulty of obtaining copper wire for extensions of and for replacement on distribution systems an effort has been made to use steel as a substitute. Steel is the only material that can be considered as a substitute but it is probable that many engineers have hesitated to use it because they were not certain as to its suitability. To assist in the use of steel wire for this purpose, Mr. Miller of the American Steel and Wire Co. prepared considerable data on the subject for the Transmission and Distribution Committee of the Edison Electric Institute and the data presented here is taken from this report

By S. O. MILLER Supervisor of Engineering and Research
American Steel & Wire Company

BECAUSE of the diversion of normally sufficient metals to armaments and war requirements, copper has been available during the past two years only for the most important installations.

Steel stands out economically as the only material available in sufficient quantities to be considered as a substitute within certain limits. Admittedly, the electrical properties of steel are inferior to copper, and steel should not be considered as a panacea in the substitution of copper, yet its use for power conductors was not instigated by war born shortages.

For many years steel has been used economically for electrical transmission and distribution circuits. With this background, it is understandable that the WPB should request the use of steel conductors.

The steel wire is to be bare with ASTM designation Class A Zinc Coating.

In the promulgation of steel as a copper substitute, the WPB realizes that steel in itself is a critical material and the board has requested the manufacturers of steel conductors to limit their stocks and production to one grade of steel that will meet the greatest number of electrical and mechanical conditions as possible.

The American Steel & Wire Co., has for the past few years made a special steel that lends itself well to electrical transmission use. This steel is made in two grades—3S-130 and 3S-80. The 130 and 80 are indicative of the tensile strength of the individual strands in thousands of pounds per square inch. The 3S indicates the number of strands. Thus, 3S-130 indicates a three strand steel wire, the wire having a tensile strength of 130,000 psi.

Due to the fact that 3S-130 grade can be strung with any other type of conductor, and has approximately the same a-c resistance as the 3S-80 grade, it is felt that the wishes of the WPB will be fulfilled by the adoption of the 130 grade as the most logical type to fit most conditions.

If a steel conductor is to be used as a neutral under a conventional conductor, the steel must have certain mechanical characteristics so that adequate conductor separations will be maintained under all loading and temperature conditions. This galvanized steel by virtue of its flat 60 F final sag curve, can be matched very readily for use in conjunction with any other conductor.

This same characteristic is even more important when it becomes necessary to substitute steel in a line already built or staked for some other conductor. Here it is necessary only to match the 50 F final sags at the shortest span, which is done by stringing the galvanized steel and conventional conductor at a reduced tension, and for all longer spans, ground clearances will actually be greater than code requirements.

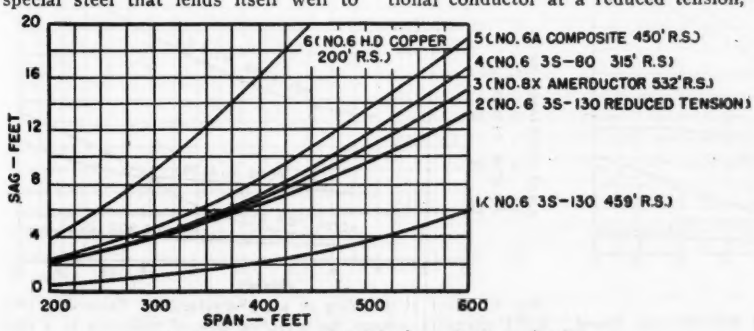


Fig. 1. Comparison of 60 F final sags for heavy loading

For the comparison of various conductor sags, Fig. 1 shows sags matched at the lowest span value as would be done if steel were substituted for both neutral and secondary on a line already staked.

As stated before, this galvanized steel can be used as an underbuilt neutral. However, such a matching requires more study to determine all relations between loaded conductors and usually requires that the line be staked for the particular combination.

This steel conductor has exceptionally desirable physical properties. By utilizing these, many economies in line design and construction are possible. Breaking strengths range from 2604 lb for the No. 6, 3S-80, to 5610 lb for the No. 4, 3S-130, which will enable the engineer to obtain longer spans without increased pole heights.

Weights of the three wire strands are 112 lb per 1000 ft for No. 6, and 156 lb per 1000 ft for No. 4. The toughness of steel makes it impervious to damage, which results in lower installation costs than softer conductors which cannot be subjected to rough handling during installation.

These conductors were primarily designed for economical long span construction. Stringing No. 6, 3S-130 on 35 ft poles for vertical construction, level ground spans attainable for heavy, medium and light loading are 563 ft, 694 ft and 762 ft respectively.

For comparison, the corresponding values for No. 6 hard drawn copper are 270 ft, 383 ft and 481 ft. Under present conditions, many organizations have completed line design and actually set poles only to find the conductor for which the line was staked is not available.

In most of these cases galvanized steel can be substituted without any changes. This is accomplished by slacking the steel conductor off to match the final sags for which the line is staked. In this way, necessary ground clearances are maintained without any excess tension loading.

In recent years we have been becoming increasingly conscious of the phenomenon known as conductor fatigue. Gentle transverse winds create eddy currents which in turn produce resonant mechanical vibrations of the conductor. At any point along the line where the conductor is clamped or supports a heavy mass, such as a splice, the motion of the conductor will be restricted.

This means that a continuous alternating bending of the conductor occurs, just as bending a small wire back and forth to break it. The conductor will also eventually break. Technically, the stresses causing this failure are known as concentrated alternating stresses.

If these stresses exceed the endurance limit of the material fatigue,

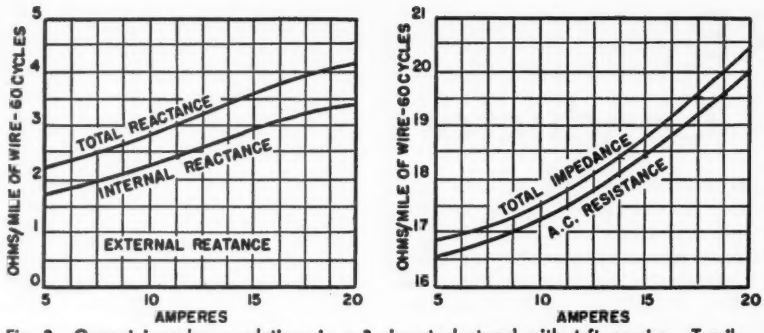


Fig. 2. Current impedance relations in a 3-wire steel strand with 1-ft spacing. Tensile strength 80,000 lb per sq in., each wire 0.105 in. diam

failure will occur, the number of stress alternations required being, of course, dependent on the magnitude of the alternating stresses. Unfortunately, copper has a very low endurance limit. Steel, on the other hand, has a very high endurance limit, below which alternating stresses will not produce fatigue regardless of how long they are maintained. Because of this, steel is an ideal material for long span construction where fatigue failures are most likely to occur.

Another important factor affecting the life of this conductor is the high quality of the zinc coating which protects it from corrosion. This protective zinc coating is applied by a hot dip galvanizing process to insure a tight alloy-bonded with a Class A coating, or 0.8 oz of zinc per sq ft of wire surface.

Use of steel conductors does not impose any hardships on construction crews. It is handled the same as any other conductor. Standard galvanized or plated hardware and fittings are used in their normal manner.

A special insulator tie is recommended for long span construction, and complete instructions for its installation can be obtained upon application. Both compression and twisted sleeve types of splices are available. In fact, the only thing that is different is the conductor itself.

Inasmuch as galvanized steel is a ferrous material, it has a relatively high permeability, which results in high internal inductance. Because of this, its internal 60 cycle reactance is so large that it accounts for an appreciable part of its total reactance for normal spacings. The internal inductance of steel strand varies from 10 to 100 times that of copper.

Of course, this is accomplished by an increase in reactive voltage drop of the line under question, but Fig. 2 shows that the overall line performance is still comparable to copper. The internal reactance is only 15 per cent to 20 per cent of the total line impedance for the assumed 12 in. spacing. For larger spacing it would be even less. Therefore, even though the internal inductance is 10 to 100 times that of copper, the overall line performance is changed by a relatively small percentage.

Steel, being a magnetic material, also introduces some complexing resistance when used for carrying a-c. Copper, being non-magnetic, is free from these resistance aggravations. The main significance of the change from copper to steel would be the substitution of larger diameter steel conductors for equivalent copper performance. Characteristics and size of the higher strength steel conductor with its increased area tends to minimize the difference in current carrying capacity due to the increased radiating surface.

The art of steel making permits a wide selection of properties from the same basic material as may be observed by the resistance range from hard drawn BB to Siemens-Martin Strand. The judicial selection of these properties has produced Amersteel Type 3S-130 with good electrical and excellent physical properties.

In steel conductors two secondary factors appear which cause power losses, thereby increasing effective resistance. These are eddy currents and hysteresis. Due to the fact that the eddy currents are large in steel conductors, they accentuate the non-uniform current distribution over the conductor area, and cause a higher effective a-c/d-c resistance ratio than is found in a copper conductor of the same area.

The component of a-c resistance introduced by the hysteresis loss in the steel is a function of the permeability. Hysteresis loss is purely a magnetic phenomenon, and results from the return of only a portion of the energy stored in the magnetic material each cycle. Hysteresis losses in soft iron, such as EBB, are much greater than they are for steel. Therefore, to determine the a-c resistance of ferrous materials, we should not place too much emphasis on d-c resistives, but should actually use a-c resistance measurements under load conditions.

As the permeability varies as a result of the magnetizing force produced by the current, the effective a-c resistance varies with the current. The effect of current on relative permeability of two different grades of steel is shown on Fig. 3. As would be expected, annealing the steel produces a large increase in permeability, which is reflected in the a-c/d-c resistance ratio.

As shown on Fig. 4, the effect of high permeability on line performance can be reduced to a marked extent. If the conductor is made of stranded wire, then high reluctance air gaps are introduced in the normal flux path and the relative reactance ratio of the conductor (designated as relative permeability) has been reduced even though the steel permeability remains constant.

Figure 4 shows that a 3-wire stranding practice has reduced the effective internal reactance to ⅓ of the value for solid wire. In the same way, a 7-wire strand reduces the internal in-

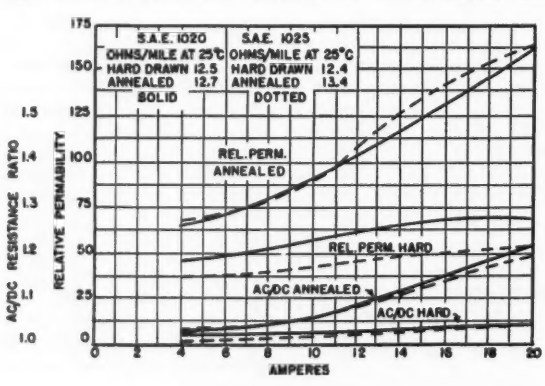


Fig. 3. Alternating current characteristics of 3x0.109 steel strand of two different steels

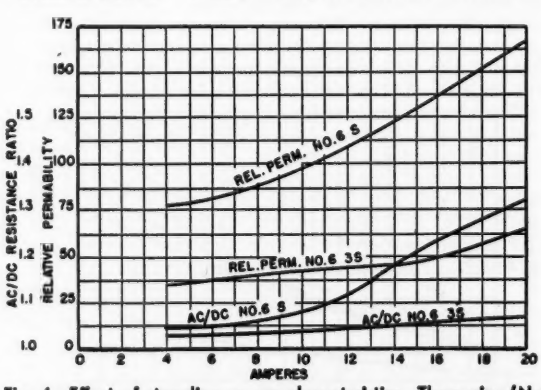


Fig. 4. Effect of stranding on a-c characteristics. Three wire (No. 6,3S) stranding reduces the effective internal resistance to a third that of the solid (No. 6,S) wire

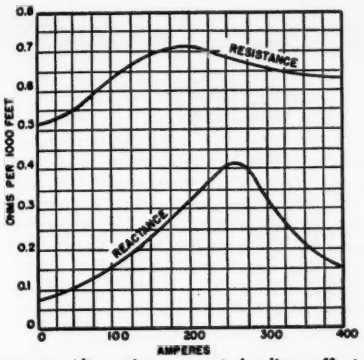


Fig. 5. Alternating current loading effect on a 7x0.164 steel strand, showing the tendency to increase to a maximum and then decrease

ductance another 20 per cent. As this means only 5 per cent decrease in line impedance, the additional expense of 7-wire strand is not justified economically.

It is interesting to note in steel that effective resistance increases with current loading to a maximum value, after which additional current loading will result in a gradually diminishing resistance, as shown on Fig. 5. Similarly, permeability will build up to a maximum with increased current loading until saturation limits the maximum, after which it, too, will diminish with further increased current loading.

It has been observed that the peak values of effective alternating current resistance and maximum permeability occur at approximately the same current loading. For the galvanized steel conductors under discussion, these maximum values are reached only with a current loading much higher than is encountered in normal service.

Rural or lightly loaded lines can be, and have been, successfully built using galvanized steel. Its usefulness in such cases can be economically extended if line design takes proper recognition of induction regulators and the possibility of adding a second phase wire as load increases. Many short taps can be served very satisfactorily with galvanized steel.

No attempt has been made here to minimize the disadvantages of steel conductors, nor pretend that a steel conductor is comparable to copper. We do feel, however, that steel has its place as a conductor even in normal times and further realize that in the immediate future the electrical industry will be forced to use steel conductors because of the critical shortage of copper.

Refrigerating Fundamentals

A short discussion of some of the elementary but still not too well understood principles of refrigerating plant operation. Mr. Bradley is a practical refrigerating engineer with many years' experience and his discussion here is based on an intimate knowledge of the average plant operator's requirements in this respect. Here he discusses the temperature-pressure relations in refrigerating systems

By HAROLD BRADLEY

To LOWER the temperature of any substance there must be a difference in the temperature of the two substances that are brought in close contact with each other. This temperature difference allows heat to flow from the warmer to the colder substance.

Principles of Ice Refrigeration

Before mechanical refrigeration was available, ice was used to remove heat from substances having a higher temperature than that of melting ice (32 F). If a temperature lower than was possible with ice alone was desired, salt was mixed with crushed ice and in this manner the ice melted at a more rapid rate and heat was absorbed more quickly and temperatures below 32 deg were possible.

In ice cream making and hardening, sufficiently low temperatures were produced by the proper proportion of the ice and salt mixtures used.

Also, in the shipping of meat and other perishable products, low temperatures were maintained over long distances by icing at loading point and reicing at intervals along the road and using ice and salt mixtures in the ice bunkers of the refrigerator cars. Even fresh fish was shipped in this manner with little spoilage.

A temperature difference existed between ice, or salt and ice, and the substance being cooled just as it exists these days between the evaporating refrigerant in a coil and the substance surrounding the coil. With ice refrigeration the heat melted the ice and turned it into water. With mechanical refrigeration the heat changes the refrigerant from liquid to vapor.

When the ice melted it was of no further use and passed out to the sewer or other place of disposal.

Mechanical Refrigeration

With mechanical refrigeration the refrigerant gives up its load of heat at the condenser and is again ready to absorb another load.

Temperature and pressure changes in the different parts of the system make it possible to continue its cycle over an indefinite period. The only loss of refrigerant is through leakage and disintegration or decomposition.

To operate a refrigerating plant properly and in an efficient manner an engineer must know which temperatures and pressures are best suited for the plant that he operates. Changing local conditions must also be met in an intelligent manner.

When ice was used the temperature difference was not controlled but depended on the temperature of the substance that was being cooled. The temperature of the melting ice was constant at 32 F.

As an example, assume that when a cooler in a meat packing plant is filled with fresh killed hogs, the temperature rises from 32 to 70 or even 80 deg. Under these conditions the ice melts at a rapid rate for the temperature difference is 38 to 48 deg.

As the room becomes colder the temperature difference becomes less until the limit of 10 to 15 deg is reached. Then, if a lower temperature is desired, more ice must be put in the bunkers or ice deck and salt added. In this manner it is possible to have a room temperature of 28 or 30 deg as is required in the cooling of hogs.

With the development of mechanical refrigeration the temperature of rooms, substances and refrigerants became definitely under control of engineers.

In usual practice a temperature difference of about 10 deg is maintained between the evaporating refrigerant and the brine, water or air surrounding the coils. The higher the temperature of the surrounding substance the higher will be the evaporating temperature of the refrigerant. The temperature of evaporation is the temperature of the saturated vapor at the pressure existing in the coils or other type evaporator.

When more than one temperature is maintained in several brine coolers or direct expansion rooms the temperature difference between the saturated vapor and the brine or air is determined by the lowest temperature carried. This is necessary so that a temperature difference will exist.

For example, consider a plant with three direct expansion rooms having temperatures of 15, 32 and 45 deg and the return vapor going to the compressors through one suction line. To have proper heat transfer a temperature difference of 10 deg is desired. This means that the temperature of the saturated vapor must be 5 deg. Using freon as a refrigerant, the suction pressure gage will show a pressure of 12 lb.

Any other refrigerant would have the same 5 deg evaporating temperature but the suction pressure would be different.

Determining Suction Pressure

When deciding on the proper suction pressure to carry refer to the tables giving the properties of the refrigerant with which the plant is charged. Select the pressure that corresponds to the temperature desired.

To obtain full capacity from the evaporator enough liquid refrigerant must pass through the expansion valve to insure that all the inner surfaces are in contact with saturated vapor and liquid as there is very little heat taken up by dry or superheater vapor.

As the refrigerant takes up heat and is evaporated it travels toward the outlet of the evaporator. If a thermometer were inserted in the outlet line it should show a temperature just above that of saturation. If full capacity is desired the temperature of the outgoing vapor should never be more than 5 deg above the temperature of saturation.

Thermometers Prove Their Worth

We know that thermometers, suitable for showing correct vapor temperature in main and branch suction lines are a bit costly, but the service they render as an aid to efficient plant operation make them a good paying investment.

Knowledge of the pressure-temperature relation of the saturated vapor of refrigerants is really necessary in the installation and operation of commercial refrigerating units. Pressure gages are not permanent equipment on these units and are connected up and used by the installation and service men only. The controls of such small units are set so as to maintain the desired temperature in the refrigerated space. Allowing the temperature difference necessary to cause heat flow into the refrigerant the controls are set to start the unit at the highest allowable temperature and to stop when the lowest temperature is reached. Such setting of controls is done by observing the gage pressures that correspond to the saturated temperature.

In an ice making plant and in most cold storage plants it is customary to maintain brine and storage rooms at near constant temperature. An ice plant will produce more ice at lower cost if the brine in the ice tank does not vary from a determined temperature.

In cold storage operation the substance in the rooms require constant temperature to make it possible to hold fruit, vegetables, meat and other perishables over extended periods of time.

The engineer should know all about the constant temperatures necessary to obtain the best results and he must maintain such temperatures inside the different evaporators as well as in the ice tank and the cold storage rooms.

Use of Tables Showing Properties of Refrigerants

As ammonia is the most common refrigerant used in both ice making and cold storage the engineer must refer to the tables giving the properties of saturated ammonia vapor. If the brine in an ice tank is to be held at a temperature of 15 deg the temperature of the saturated vapor in the ice tank coils must be 5 deg. The tables show that this 5 deg temperature corresponds to a gage pressure of 19.57 lb. It will be found that in the majority of ice plants a suction pressure of about 20 lb gage is maintained. Many engineers know that this is the proper pressure for ice making but not half of these operating engineers realize that the gage is really stating the fact that the temperature of the saturated vapor in the ice tank coils is 5 deg.

Effect of Method of Cooling Brine

For many years all ice making tanks (except plate or center freeze) used pipe coils located between the rows of cans and the 10 deg temperature difference between the evaporating ammonia and the brine was accepted as the best for good results.

Now we find that many ice making plants use different types of brine coolers and other arrangement of coils, and also the speed of flow of the circulating brine has been greatly increased. A temperature difference of as low as 5 deg is possible in some plants where shell and tube type brine coolers are located in the tank. In such cases the suction pressure is carried higher to correspond with an evaporating temperature of 10 deg, gage pressure about 24 lb. The temperatures and pressures carried in general cold storage plants are just about the same as those maintained in the ice plants.

The foregoing statements of plain facts show that the correct temperature difference and suction pressure carried will depend on the manner in which the brine is cooled in the individual plant that is being considered.

An engineer must first study the load, in heat units, that must be taken from whatever substance is being cooled and the length of time permitted. Next, determine (from tables available for this purpose) the rate of heat transfer per sq ft evaporator surface per deg difference in temperature. This will show what difference, in temperature, there must be between the evaporating refrigerant and the substance being cooled. This will also indicate the proper suction pressure to carry.

Overall Efficiency

Many engineers make a great mistake in giving too much attention to the idea that the overall efficiency of the entire plant depends almost entirely on the carrying of high back pressure. The weight of refrigerant handled by the compressor increases with higher suction pressure and lower amount of superheat.

The evaporating coils, however, are just as important with respect to plant efficiency as the compressor and the object should be to gather the greatest number of heat units in the shortest time and send them to the condenser.

Just what is going on in the evaporating part of a plant must be learned by careful observation and study. We cannot see the refrigerant as it travels through the different parts of the system so we must depend entirely on the facts that are shown by the pressure gages and thermometers.

Pressure-Temperature Relations

The temperature of the substance that surrounds the evaporating coils will be the guide for us to know what state and temperature the refrigerant has inside the evaporator. Allow the proper temperature difference and then regulate the expansion valves so as to give the outgoing vapor the saturated or superheated state that is required to take up the amount of heat that the evaporating refrigerant should absorb.

If the refrigerant leaves the evaporator in a dry, saturated state we can be sure that the vapor reaching the compressor will have a few deg of superheat. In its passage into the compressor more heat is taken up and, under ordinary operating conditions, the superheated vapor will have a temperature of about 65 deg at the end of the suction stroke of the piston.

The pressure-temperature relation of the refrigerant is of further importance in the operation of the condenser. The highly superheated vapor passes into the condenser and gives up its superheat to the condensing water. When the superheat has been removed the vapor assumes the saturated state. In some condensers the saturated temperature of the vapor will be as low as 5 deg higher than the condensing water. At the saturated temperature and its related pressure condensation takes place. This determines the pressure that exists in the condenser.

Refer to the tables and locate a saturated temperature 5 to 10 deg higher than the temperature of the condensing water. The pressure that corresponds to this temperature is the condenser pressure that it is possible to maintain providing that the condensing surfaces are clean and in close contact with sufficient water and that the system is fully charged and free of non-condensible gases and other impurities.

The pressure-temperature relation does not exist after condensation takes place and the refrigerant assumes the liquid state.

There are just two places in the refrigerating system where the pressure-temperature relation of saturated vapor exists. One is in the evaporator where heat is absorbed and vaporization takes place; and the other is in the condenser where heat is given up and condensation takes place.

THE WELL KNOWN psychological effect of color is now being used in the design of machines. In a recent survey it was found that for a certain lathe a "spotlight" buff at the working areas and a "horizon" gray on the machine body increased operating efficiency. The accident hazard is reduced through proper color selection by increasing the visibility of moving parts by "spotlighting" with color or by silhouetting against a background.—The Ohmite News.

Power and Industrial Plant Maintenance

Readers may recall the special section published in the September issue devoted to the wartime training of personnel in power plants. In the collection of data for that issue we accumulated much more than could be published in that issue. Among the many splendid reports and statements submitted to us was this article by Mr. Jensen on plant maintenance. Mr. Jensen has held many responsible positions in the field of supervision and construction with large utilities and manufacturing companies and his discussion of plant maintenance presented here is based on a thorough understanding of maintenance requirements in various types of plants

By M. A. JENSEN

AT NO TIME in the history of American industry has the need for keeping the wheels turning been more vital than now. So closely related are the wheels of industry in this country to the activities on the various and far distant battle fronts that any stoppage or slow down here is tantamount to an equivalent stoppage or slow down of our valiant and hard driving fighting forces.

Marvelous results have been accomplished in industry in our country since the advent of its entry into this war. Thousands of new plants have been built and equipped with standard and special production equipment, the arrangement and manning of same has been such as to insure the very maximum of quality and quantity of production.

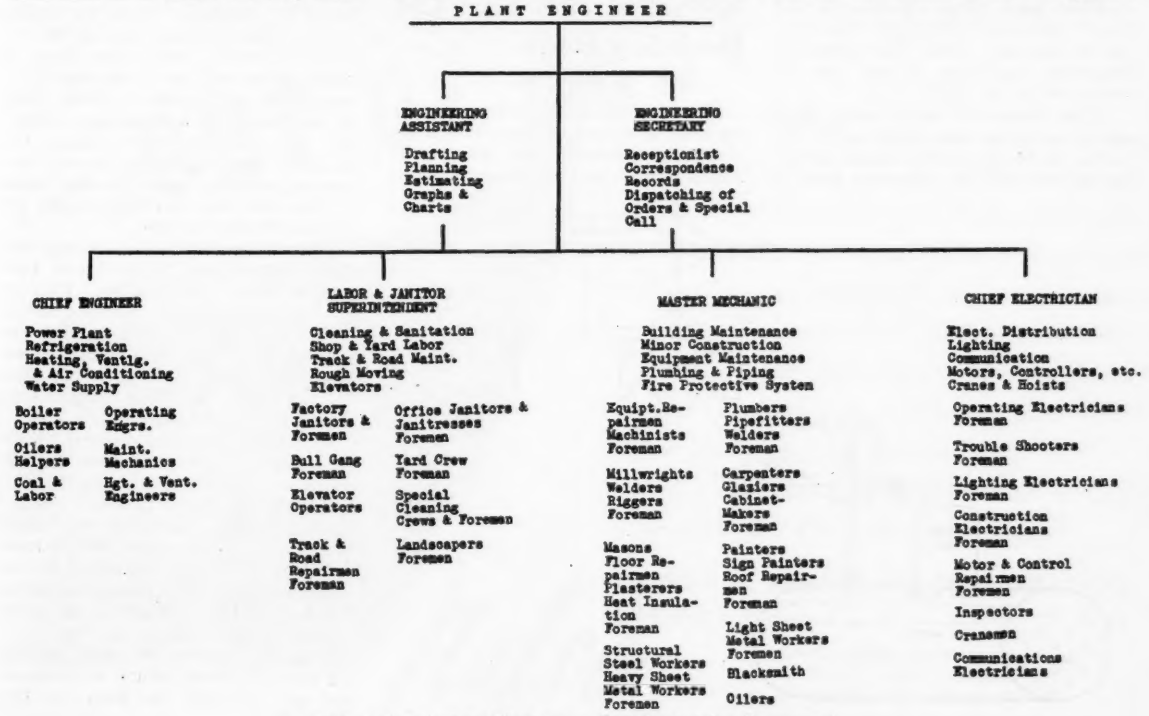
However, to the extent that a chain can be no stronger than its weakest link, likewise neither can the efficiency of the production plant be any better than the power and maintenance facilities serving it.

Truly, the power and maintenance engineer of today is charged with heavy responsibilities, for upon his shoulders fall the burden of "keeping the wheels turning." Unfortunately, the means at hand for assisting the power and maintenance engineer have in no manner been comparable to that rendered his front stage coworker, the production engineer. Indeed, the field of action of the power and maintenance engineer is far removed from fanfare and klieg lights.

It is not surprising therefore in many cases to find this department the most poorly equipped and organized of any in the plant. In all too many cases, the work of the power and maintenance engineer is performed on the basis of urgent necessity and in an atmosphere of discomfort and stress. Records, or any other evidence of planning or system are often totally in absence with the inevitable result that the power and maintenance department and all its components and functions are relegated to the back of the stage and labeled as a necessary evil.

This state of affairs, while to a great extent the fault of the power and maintenance engineers, by no means can or should the top management be absolved from responsibility for its existence. The responsibility of top management in this case is clearly to recognize the importance of the function of power and maintenance and to afford it a degree of recognition commensurate with its value to the industry. Indeed, some farsighted executives are now giving this department equal ranking with all other departments.

In such cases this department is headed by an engineer specially qualified by virtue of technical training and extensive experience up through the ranks to hold such an important position. Various titles are given this position such as plant engineer, superintendent of maintenance, chief engineer in charge of power and maintenance, or maintenance engineer. However, the matter of title is not as important



Typical Organization Chart for a Plant Engineering Department

as the selection of the right man for the job and then making it possible by virtue of recognition and support for his success. Most certainly this is not a job for a young man just out of college, nor is it a job to hand an untrained man as a political reward or a reward for long service with a company in another capacity. The right man in such a position will lose no time in the development of an organization adequate for the requirements. This obviously will vary with the nature and size of the industry being served.

The accompanying illustration shows a typical organization chart covering a plant engineering department.

In addition to thoroughly organizing the necessary working force into divisions and placing each under competent leadership, the power and maintenance engineer will provide each with the necessary complement of equipment, tools and quarters.

He will also, with the assistance of his division leaders, compile schedules of planned or periodic maintenance service to cover all buildings, structures, and distribution systems, roadways, tracks and equipment in service. Schedules covering production equipment will of course be approved by production officials. In addition he will provide for a comprehensive system of records which will cover the operation or functioning of all items coming under his care.

In this manner, all buildings and equipment will receive the necessary care and attention well in advance of acute need and by virtue of such attention equipment is maintained in the best possible working condition and equipment outage is reduced to the minimum.

The alert power and maintenance engineer will keep abreast of the times by reading the leading technical periodicals and attendance at engineering society meetings. The knowledge gained thereby will be reflected further by wise and careful selection of supplies, material and equipment used by his department and the advice which he will give to other departments.

PRACTICAL HINTS AND KINKS

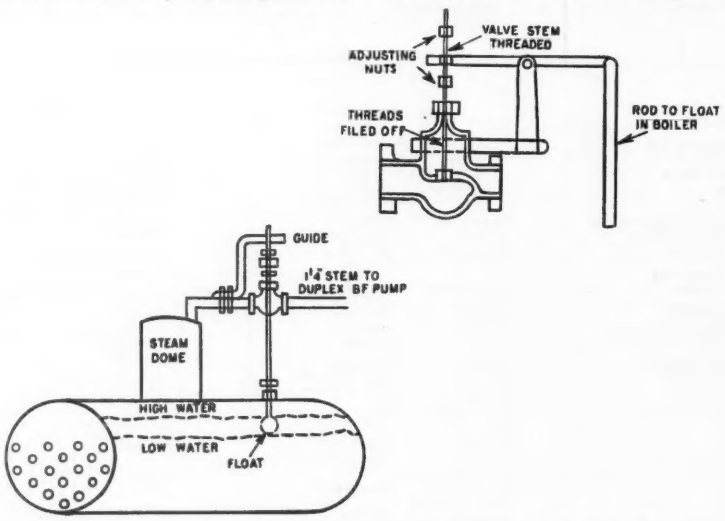
Old-Time Feedwater Control

By Thomas M. Street

IN OUR MODERN POWER plants with their many gadgets for this and that I don't suppose the attached sketch of a boiler feed pump regulator would prove interesting except as an example of necessity being the mother of invention, and what a man can do when he has to do it.

I ran across this device many years ago in a cotton gin down south attached to 125 hp return tubular boiler. It will be noted by adjusting nuts on valve stem the water level in boiler was maintained pretty constant with a variation of not more than an inch.

Am passing this along as an illustration of what old timers used to do before modern gadgets were invented.



Sketch showing old-time arrangement to maintain water level in hrt boiler

Special Scraper from Old Hack Saw Blade

By Wm. O. Sinn

IN THESE TIMES when most all metals are listed as critical we have found a way of getting double use from worn out or broken power hack saw blades. Quite a

Grind edges A and B on old hack saw blade for scraping hand-hole gasket surfaces

variety of scrapers can be made, one of which is shown by the accompanying sketch.

This particular scraper comes in mighty handy in work on water-tube boilers in the scraping of both gasket surfaces on the hand-hole caps and the surface inside the tube headers.

A bevel edge is ground at A and this edge is used for cleaning the gasket surface of the hand-hole caps. A notch is ground in the side of scraper and edge B is used for cleaning the gasket surfaces on the inside of box headers. By partially grinding away the teeth, a non-slip surface is provided for holding the scraper.

Overcoming Alinement Headache

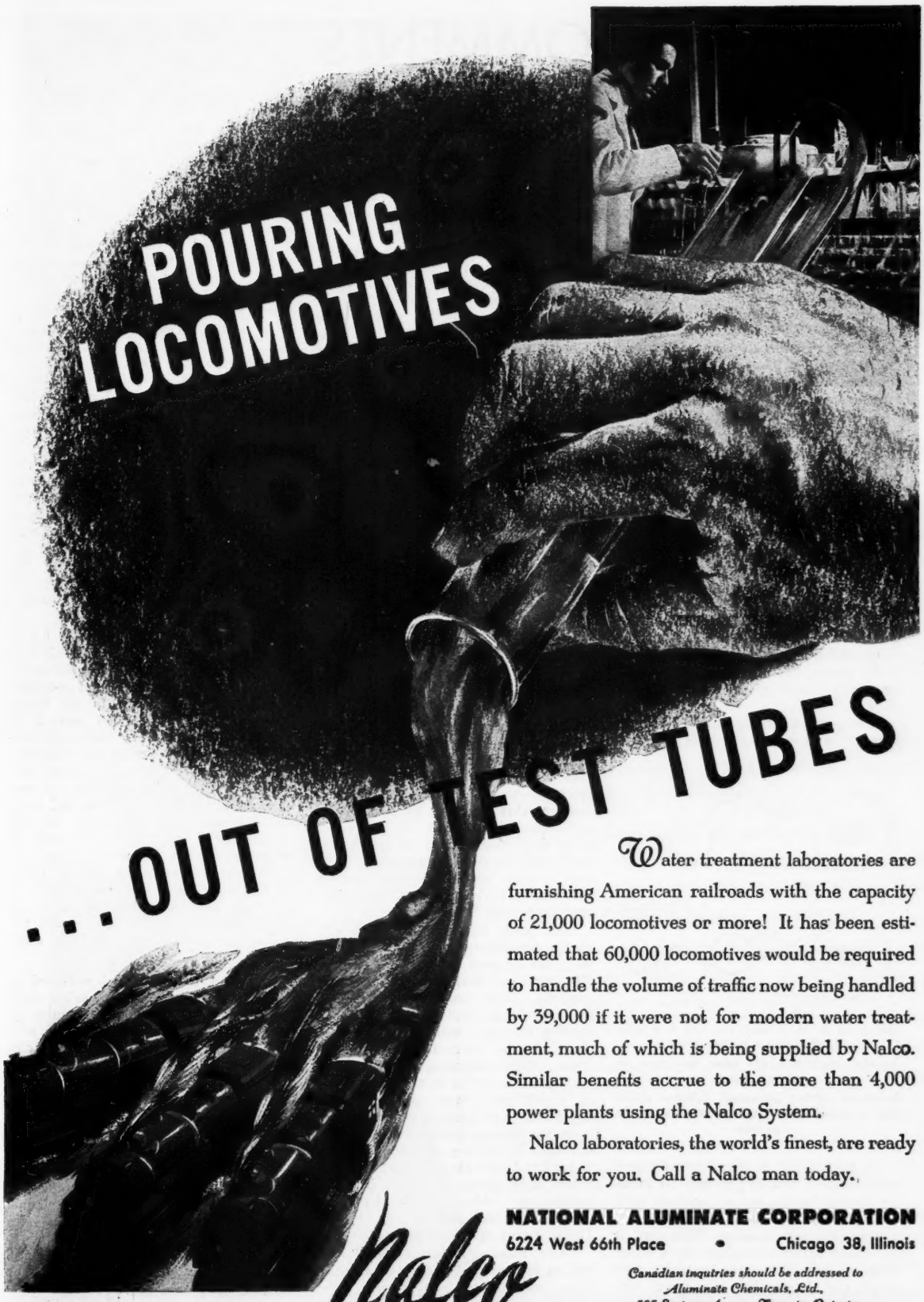
By William Otto
Chief Engineer
Carson Pirie Scott & Co., Chicago

AMONG MANY other pieces of equipment, we have a 10 hp, 3600 rpm condensing turbine driving a gas booster for gas-fired boilers through a flexible coupling. This gas booster is mounted on the side of a structural steel box frame, made from angle iron and housed with ½-in. boiler plate. The impeller of the gas booster is mounted on a 2-ft length of shaft running through two ball bearing pillow blocks which are mounted on 4-in. channel iron to the box frame.

Since its original installation some five years ago, we have had considerable trouble with this equipment in maintaining proper alinement. When the turbine was cold, the alinement was correct but when the turbine ran a few hours, it would throw itself out as much as ⅛ in. causing the gas booster to vibrate. This, in turn, caused the ball bearings to break up. This occurred several times. The expansion and contraction due to temperature, evidently caused the steel frame to move and thus contribute to the destruction of the bearings.

Recently we rebuilt the bearings; had them reground and installed new balls together with a new coupling. Then we lined the gas booster up with the turbine to within 0.0001 in. Hoping that our troubles were over, we started the machine once more. But, "no soap", after approximately two hours, the same trouble developed again.

The turbine was shut down and while the machine and steel structure was still warm we poured concrete into the steel box that supports the pillow blocks and the gas booster. This box holds about two cubic feet of concrete. We let it set for about 24 hr, then started the turbine and somewhat to our surprise, the turbine ran so quiet, I thought at first that someone had disconnected the coupling. At this writing the machine has been running for over two weeks without a shut-down and still as quiet as when we first started it.



Water treatment laboratories are furnishing American railroads with the capacity of 21,000 locomotives or more! It has been estimated that 60,000 locomotives would be required to handle the volume of traffic now being handled by 39,000 if it were not for modern water treatment, much of which is being supplied by Nalco. Similar benefits accrue to the more than 4,000 power plants using the Nalco System.

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THE COMPLETE WATER TREATING SERVICE

LETTERS AND COMMENTS

Where Should Idler Pulleys Be Located?

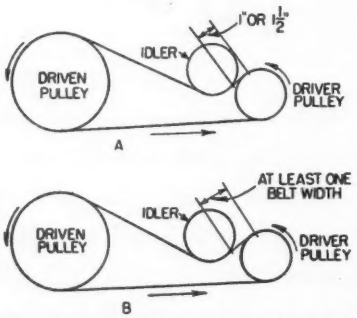
IN POWER PLANT ENGINEERING'S Questions & Answers, 7th Edition, the question on pages 276 and 277, Where Should Idler Pulley Be Located?, prompts me to add some comments that I hope will help all users of leather belting.

In the example illustrated, the questioner recommends locating the idler pulley 1½ in. from the last point of contact of the belt with the driver pulley, in order to gain the maximum amount of wrap around the pulley. I believe this distance is too short.

I would recommend that the idler be located so that a distance at least equal to the width of the belt is left between the point where the belt leaves the motor pulley and the point where it first touches the idler.

The reason for this is that when the belt comes around the crowned motor pulley, it should have adequate space to straighten itself out (transversely) before another reverse bend is produced in it by the idler. If this is not done, there is a crinkling effect that causes a characteristic break at right angles to the length of the belt, in its center. If allowed to continue, this will break clear through both plies.

The attached sketches illustrate how I would install the idler.



Sketch by R. H. Rhoads showing how idler installation can be improved

A—Not recommended; idler too close to driver pulley

B—Much better; increased distance allows belt to straighten out before reversing again at idler

It is true that an idler correctly used will enable a belt to pull heavier loads by increasing its arc of contact with the pulleys. In short, the idler increases the belt capacity. However, it is usually better practice to use a wider belt to gain the same capacity and avoid the shorter belt life, lower efficiency and increased maintenance expense that result from the use of the idler.

Belt users interested in further discussions of idlers and other belting problems will find excellent data in Haven & Swett's Treatise on Leather Belting. (Published by American Leather Belting Assoc., New York City, price $1.50. Although written 10 yr ago, it is still considered an authority on sound belting practice. —Ed.)

There is a definite tendency in modern installations to avoid the use of idlers wherever possible and instead to use the modern pivoted motor base, such as those made by Rockwood or American Pulley Co. Through the use of such bases, the weight of the motor swings around the pivot in such a way as to provide correct belt tension. This insures higher efficiency and longer belt life.

Philadelphia, Pa. RICHARD H. RHOADS

The Egg-Shell Scale Episode

SEVERAL WEEKS AGO I was called in by the manager of a company manufacturing medical supplies and was asked if I would re-tube one of his boilers. He said that it was necessary for him to have the work done as soon as possible and while in his office he had me read his last boiler inspection report which as far as his boilers were concerned gave him a clean bill of health. The report stated that the boiler was noted to have egg-shell thickness scale. After reading the inspector's report I suggested to the manager that we go to his boiler room and look things over. It proved to be a nice boiler room of which any man could be proud; everything clean and in order and it gave the impression that here was a plant well operated and well cared for.

The plant consisted of two boilers with a manufacturer's rating of 50 hp each, set in steel casings operating at 100 psi gage and stoker fired with controls. The boilers were of the two-pass design, the furnace gases first passing through twenty-six 4-in. tubes placed in the lower back ring of the boiler, then returning to the front through 3-in. tubes in the upper shell of which the lower front part was exposed to the product of combustion from the furnace proper. There was a manhead in the top of the upper shell and a hand hole plate in bottom of the lower shell along with the blow off connection. Also, in the backhead, under the lower row of tubes, was a 1½-in. brass washout plug.

After looking his plant over I could not understand why such a well-kept plant was having trouble with tubes. So I asked the manager how long the tubes had been leaking, and he informed me that they had been having trouble for quite a while; also that they had on three different occasions in the past four months rolled the tubes to stop leaking. The last time they had leaked so badly that they put the fire out.

By this time I was having ideas of my own and the beauty of his plant had ceased to impress me. It was good looking only on the outside but quite obviously rotten on the inside. I asked the manager if he was using any kind of boiler feedwater treatment and he informed me he was and if the inspector's report was true, and he judged it was, his water treatment was doing a very good job. I asked him if it was fed continuously or in doses; his reply was that it was fed in doses. I also inquired when his boiler was blown down and the engineer in charge said he blew twice a day; at 9 a. m. and 3 p. m. while his boiler was working. I asked him if he did not feel it would be better to blow his boiler off when it was idle as there would be more solids at the bottom of the boiler than when under full steam. His reply was that the latter way was the way he had been told to blow off but that the boiler was always steamed up when he came on. This reply led me to ask why the night watchman could not be instructed to blow off in the proper manner but he gave no reply.

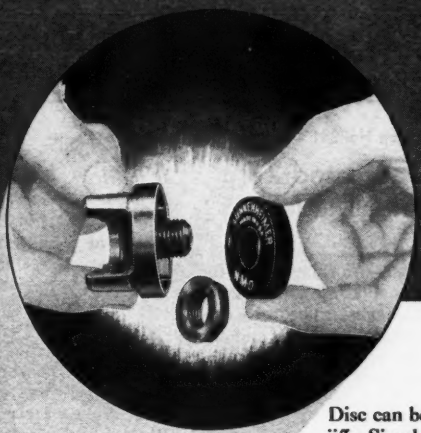
After studying the situation I told them frankly that I thought scale was their trouble and only scale, to which they would not agree. So I removed one of the 4-in. tubes in the lower part of the boiler, which took 2 hr or more due to a very bad scale condition. When this tube was removed from the boiler the scale deposit was so heavy that all you could see was just the hole where the tube had come out. I asked the engineer if he ever had cleaned out his boilers and he informed me that he washed them out every three weeks, but that he never had removed the washout plug in 14 yr. He had noticed lately when he blew down his boiler that it did not blow like it used to. Still he made no effort to find out why.

We set to work and removed as much of the scale as possible with bars and rods, replaced the tube we had taken out, filled the boiler with water and added a strong caustic solution and boiled this for 72 hr. Then we gave the boiler a good washing and then repeated the operation. After giving the boiler a final wash, we filled it up, raised steam, and she went merrily along.

This manufacturer has several good chemists on his staff of employees and I asked the manager why could not the engineer have taken a sample of his boiler water every day to one of his chemists who could in a few minutes have told him if he should or should not add more treatment and all the trouble would have been avoided. They are doing it now.

Seymour, Ind. WM. F. HEIWIG

Here's how to make your present Valves ...LAST LONGER ...SERVE BETTER



Disc can be renewed in a jiffy. Simply unscrew locknut from disc holder, remove old disc, insert new one and reassemble. Or better still, keep on hand some spare disc holders complete with discs—slip a disc holder and a new disc on the stem and remove the old disc later.

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Today when new valves and even repair parts are scarce and require high priorities, it is more essential than ever to take good care of the valves you now have in service.

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BRONZE, IRON, STEEL AND CORROSION RESISTANT ALLOY VALVES, 125 TO 2500 LB. S.P.; BOILER MOUNTINGS, LUBRICATING DEVICES, AIRCRAFT FITTINGS. ASK FOR CATALOG 78

Questions And Answers

Question No. 241

How Is a Depressed-Zero D-C Voltmeter Made and Used?

KINDLY GIVE ME information on the theory and construction of a depressed-zero scale d-c voltmeter. The zero corresponds to a potential of 200 v and the scale ends at 275 v. I understand this type of voltmeter is to show compounding of a generator on a larger scale reading than the usual type.

Lansdowne, Pa. H. L.

Editor's Note—This type of voltmeter is no different from an ordinary meter except that the spring which actuates the pointer is so adjusted that the voltmeter will not indicate any voltage until it reaches a certain minimum value. For example, if you want to use such a voltmeter to show the compounding of generators you really are only interested in a comparatively short range of voltages in the neighborhood of the full load voltage of the machines. If this is, say, 125 v, then your depressed-zero scale voltmeter would probably not start registering until the voltage of the machine had reached the value of, say, 100 v, and it would continue to register up to the maximum value which might be 150 v. The 125-v indication, therefore, would be in the exact center of the scale.

The reason for using such a voltmeter is to secure a much larger scale over the range of voltages that you are interested in than would be obtained by the use of an ordinary voltmeter which read all the way down to zero.

Question No. 242

How Much Heat Does Pipe Insulation Save?

IF YOU HAVE 60 ft of 6-in. pipe, 100 ft of 4-in. pipe and 100 ft of 2-in. pipe carrying 160 psi steam and all without covering of any kind, and with many tees and elbows in it for good luck, how much heat is lost, as compared with insulated pipe? To put it the other way, how much heat would you save, either in Btu or in the coal pile, by covering all the pipe?

Lee, Mass. M. G.

Editor's Note—It seems strange that this question should come up, after all that has been said and written on this subject. But the questioner is apparently sincere. Furthermore, in these days when coal saving is vital to the conservation of manpower and transportation, as well as of fuel itself, it may be well to comment on it briefly. Often an engineer will have to argue the subject with some layman who can't see why he should spend any money to insulate a little bit of piping and some general figures that can be easily remembered may prove helpful and save time when the standard handbooks are not available at the moment. That is probably the situation that led to this question. Assuming a steam pressure of 160 psi gage and an air temperature of 60 F around the pipe, the heat losses in Btu per lineal foot per hour for bare pipe in the sizes in which you are interested, are given by one authority as follow:

For 6-in. pipe—1555
For 4-in. pipe—1085
For 2-in. pipe— 597

Since you have 60 ft of 6-in. pipe and 100 ft of 4-in. pipe and 2-in. pipe, respectively, the total heat loss from this piping system is as follows:

1555x 60 =	93,300
1085x100 =	108,500
597x100 =	59,700
	261,500
Add 5 per cent for fittings	13,075
	274,575 Btu loss per hr

If this same system were covered with 1½ in. of canvas-covered magnesia insulation, the heat loss in Btu per lineal foot per hour for the three sizes of pipe would be as follows:

For 6-in. pipe—167
For 4-in. pipe—123
For 2-in. pipe— 79

Thus, for your piping system the calculations again are as follows:

167x 60 =	10,020
123x100 =	12,300
79x100 =	7,900
	30,220
Add 5 per cent for fittings	1,511
	31,731
Loss from bare pipe	274,575
Loss with 1½ in. insulation	31,731
Saving by insulation	242,844 Btu per hr

Thus you will note by merely covering your piping system with 1½ in. of insulation you will save on an average of 242,844 Btu per hour. Heat losses from bare pipe may range from 2 to 5 Btu per square foot (of pipe surface, not per lineal foot) per hour per degree temperature difference between steam or water flowing in the pipe and the external air. This value is not constant and in general is higher for small pipe and large temperature differentials. Also it is assumed that still air surrounds the pipe, otherwise the loss may be even higher. A chart showing heat losses of bare wrought iron pipe for various temperature differences was published on page 90, P. E. & E., February 1940.

As to the actual saving in coal in the above example, if you had a 12,000-Btu coal you would save the heat equivalent of about 20 lb of coal per hour in the steam but since boiler efficiency might be 65 or 70 per cent, this might be nearer 25 lb of the coal burned. In 12 hr this would be 300 lb or roughly 1 ton of coal per week or 52 tons a year.

The above is only a most general picture of the situation. Many other factors, such as costs, types of installation, methods of installing it and the like, enter it but data on these are readily obtained from the various manufacturers of insulation. For example, while we have used 1½ in. thickness of insulation in the example, the economical thickness might be more than that, depending on the cost of coal or value of heat per 1,000,000 Btu, the number of hours of operation, temperature difference, conductivity and cost of insulation and fixed charges. The relations between these factors have been charted and published in various forms. One such chart is on page 788, ASH&VE Guide 1943.

Question No. 243

How Improve Draft With This Chimney?

IN ONE of our buildings we have a stack with an area at the top of 35 in. by 35 in. The stack is 50 ft high above the grates. The best test we have been able to get on the boiler was 0.08 of an inch on the draft gage with 535 F temperature (of flue gas, we assume—Ed.) The stack is built tapering in as it nears the bottom.

The boiler is a heating boiler and the specifications call for a 20 in. diam stack. The smoke pipe where it enters the stack is 18 in. in diameter. My questions are:

1. Is the low draft due to a down draft caused by the excessive size of the stack or is it due to the increase in the size of the stack after it leaves the smoke pipe?

2. Can the draft be increased by putting an 18 in. diam pipe, about 8 or 10 ft long, on the top of the present stack?

Tacoma, Wash. C. E. D.

Editor's Note—The whole subject of draft and capacity of chimneys is thoroughly discussed in Draft and Capacity of Chimneys by J. G. Mingle, published by D. Van Nostrand Company, New York, price $3.50. See also Mr. Mingle's authoritative articles, Performance Characteristics of Natural Draft Chimneys, Power Plant Engineering, April, 1939, page 245 and The Easy Way to Select Economical Chimney Sizes, Power Plant

EDWARD 6000 LB HYDRAULIC VALVES

FOR PUNISHING PRESSURES

FIG. 158 GLOBE

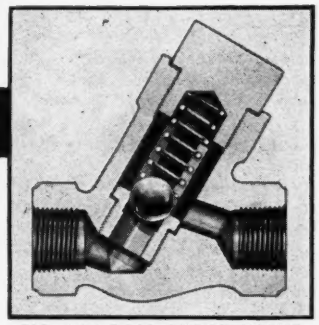
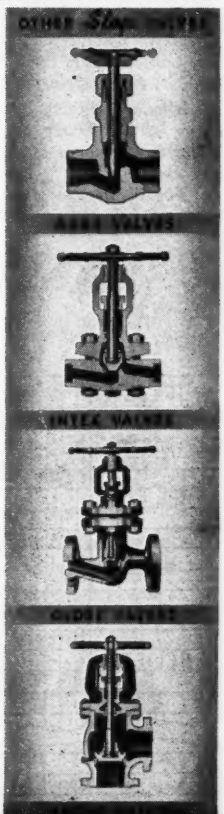


FIG. 160 BALL CHECK VALVE

THOUSANDS of excessive pressure systems operating under 300 F depend on Edward Fig. 158 globe hydraulic valves for fast, certain shut-off or accurate pressure control.

The seat and swivel needle disk are made of EValloy, Edward's own development in abrasion resisting stainless steel. The inside screw construction, the extra deep stuffing box and the special gland and packing nut design lengthen packing life and prevent leakage along the stem. Streamlined body contours permit free flow at high velocities with low pressure drop.

These—and other—specific advantages of Edward Fig. 158 valves add up to savings in maintenance time and replacement parts. For information on valves in the Edward line write for Edward BETTER VALVES Catalog No. 101.



Corresponding ball check valves, Fig. 160, with same ratings, also available.

DIMENSIONAL DETAILS OF EDWARD Fig. 158 and 160 HYDRAULIC VALVES
For power, petroleum, chemical process, marine, technological or general industrial service
Rating 6000 lb at 125 F
Globe type, screwed or socket welding ends

SIZE	¼"	⅜"	½"	¾"	1"	1¼"	1½"	2"
End to End, Fig. 158 and 160	3¾	3¾	3¾	4½	5⅛	6½	7½	9
Center to Top Open, Fig. 158	8¼	8¼	8¼	9¼	10⅞	13¾	14⅞	18
Handwheel Diameter, Fig. 158	5⅜	5⅜	5⅜	6⅜	8½	10⅛	10⅛	11½
Weight—lbs, Fig. 158	3¼	3¼	4¾	7	12	22	37	62
Weight—lbs, Fig. 160	1½	1½	2¾	4½	7¼	13½	19¾	40

THE EDWARD VALVE & MFG. CO., INC., 220 W. 144th Street
East Chicago, Indiana

EDWARD *Steel* VALVES

Engineering, April, 1942, page 86.

According to Mr. Mingle's book, page 42, also Steam Power Plant Engineering by Harding, page 112, the total head or draft, H, in inches of water, produced by a chimney is $H = 7.64\ L\left(\frac{1}{T} - \frac{1}{T_e}\right)$

where L is the height of the chimney above the grate in feet, T is absolute temperature of the outside air in degrees F and T_e *is absolute temperature of the chimney gases in degrees F.*

If we assume an outside air temperature of 60 F then $T = 60 + 460 = 520$ *and* $T_e = 535 + 460 = 995$. *Then*

$$H = 7.64 \times 50\left(\frac{1}{520} - \frac{1}{995}\right)$$

$$= 0.342 \text{ in. of water}$$

which should be theoretically possible with a chimney of this height and of the proper diameter and which should be sufficient for this type of boiler.

A chimney of too great a diameter, however, as this one clearly is (resulting in a cross-sectional area about 5 times that required) will cause the gas velocity to be relatively low, the temperature of the gases will drop rapidly as they pass up the chimney because of the relatively long time they are in the chimney and the result will be low draft.

The cause of the trouble is clearly that the area of the chimney is too big. Also the sudden enlargement of the area at the smoke pipe connection to the chimney will doubtless cause a sudden drop in velocity at this point, with a loss of draft.

Would it do any good to increase the taper of the smoke pipe from 18 in. in diameter to about 30 in. where it joins the chimney?

The above problem is different from that of selecting a chimney of proper size to fit certain known combustion conditions and since it is typical of the difficulties encountered in using what you have or can get under wartime conditions, we present it for further discussion.

Answer No. 231

Who Has a Work Schedule for a 6-Day Week?

HERE IS ANOTHER good 6-day schedule to add to the group of schedules sent in by Q & A readers in response to R. J. K.'s request in the July issue. Some of these were published as an article entitled Work Schedules for a 6-Day Week on pages 94-96, P E & E, October, 1943, issue. Our heartiest thanks to all those who cooperated by sending schedules. This is one of those details of plant organization that can be very important in producing a smooth-running, congenial and efficient power plant team.

Work Schedule from Lutz

I AM ENCLOSING a copy of the master schedule for a 6-day work week, which has been in use in a number of utility plants operating 7 days a week, 24 hr per day. It is a rotating type schedule, covering a complete cycle in seven weeks.

Row I shows the schedule applied to one job, providing continuous coverage with three full time men and a relief man part time.

Row II shows the schedule as it applies to two jobs, giving continuous coverage on both jobs with six full time men and a full time relief man.

The advantages of this schedule over any others tried are that:

1. Each man, including relief, works the same rotation of shifts and the same number of days per week;
2. It provides the same number of days off for each man;
3. It provides that each man shall have an equal number of each of the days of the week off in a given period;
4. There are no changes of shift without an intervening day off;
5. One relief man can exactly cover two jobs without having any free days or uncovered shifts.

East Orange, N. J. W. J. LUTZ

Answer No. 233

Why Does the Flow Meter Lag?

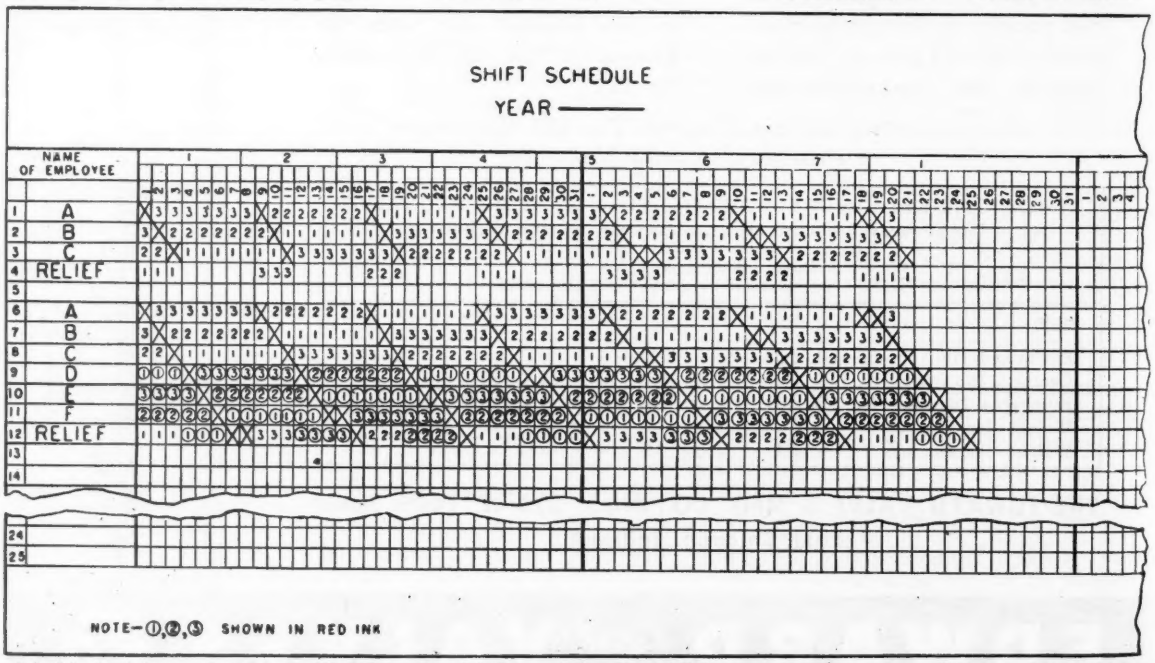
THE LAG in return to zero of No. 2 flow meter must be due to some condition in the connections from the orifice to the meter proper. Inasmuch as meters and installation have all been double checked, there must be some obstruction in the connecting line acting to prevent the return of the differential pressure to zero after steam flow has stopped.

I would visualize this as scaly material lying in the loop below the orifice. When the steam is first turned on and flow is at a maximum there is sufficient pressure to float these particles up the loop and permit the meter to record. After a time the particles settle again into the bottom of the loop and act as an obstruction to prevent the rapid return to zero after flow ceases.

This could be checked by turning on the steam again after the meter had dropped to zero and then shutting it off in a minute or so. If the meter then returned to zero immediately it would indicate the particles did not have time to settle and obstruct the flow.

How they would get in may remain a mystery but their removal would be simple; blow the lines well with air or steam and reconnect.

Philadelphia, Pa. THOMAS W. BENSON



Schedule for 6-day week sent in by W. J. Lutz. Row I is for one job, with 3 full-time men and 1 part-time relief man. Row II is for 2 jobs, using 6 full-time men and a full-time relief man. Schedule can be extended to right to cover a full year

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CRANE VALVES

Answer No. 236

Why the Difference in pH In These Two Boilers?

Look at Sampling, Blowdown, Water Analysis, Says Clark

BY CAREFULLY checking the following four important factors the solution to H.E.'s difficulties should be found:

1. The water sample must truly represent the water in the boiler. The sampling point should be in a zone of active circulation, as far as possible from the feedwater inlet pipe. Since all boilers are fitted with two blowoff valves, it is an easy matter to install a sampling line between valves and draw a sample by opening the inner valve. This should be done immediately following a regular blowdown. This sample can be checked against a sample taken at the same time from the usual point.

2. The method of collecting the sample must be such as to eliminate errors caused by evaporation or deposits in the sampling pipe. The sampling line should be thoroughly blown out before a sample is taken. If the boiler pressure is such that an appreciable quantity of steam flashes, a cooling coil should be used in taking the sample for analysis.

3. The ratio of total blowdown to total steam production must be the same for each unit. No statement is made of blowdown quantity. If continuous blowdown systems are fitted, it is important that the connections be at such points as to draw off the most concentrated water. Samples for analysis should always be taken at the same time with reference to any intermittent blowdowns.

4. There may be materials in the water which make the values being checked inaccurate by the method used. If this is the case, alkalinity can be readily determined by titration. Also other elements such as chlorides or sulphates could be checked, depending on the water anlysis and chemical treatment. If the feedwater analysis, steam production and blowdown quantity are known or can be estimated, then the concentration of any element in the boiler water can be closely calculated.

Saint John, N. B., Canada — C. G. CLARK

Answer No. 237

How De-Mud Reservoir Without Shutdown?

The Suction Nozzle Gets Another Vote

L. W. L. might be able to remove the mud from his cooling tower without shut-down and without stirring up the mud excessively by rigging up a dredge pump similar to those used for dredging channels or for pumping gravel from a gravel pit. The pump could be mounted on skids beside the tower and the suction nozzle would then be moved over the basin floor, sucking up the mud and some water as it goes.

The suction nozzle, hose, and pump would have to be large enough to pass the scale and debris which may have accumulated in the basin without clogging. The pump should be large enough to maintain good velocity in the suction hose and piping and thus prevent the mud from settling out and plugging the system.

If the sides of the cooling tower are open, this might be worked from outside the tower, using a long pipe on the nozzle; or it could be worked by lowering the water level in the reservoir enough so that men could work inside.

Kansas City, Kans. — E. R. KETCHUM
The Marley Company, Inc.

Answer No. 238

Why Electricians Chew Their Fingernails

HERE ARE more comments on the above, which had two parts; a. What is the best way to build up the field of a generator that has lost its residual magnetism; b. How can the copper cooling coils of a transformer, which is running hot, be cleaned of scale and kept clean.

Residual Is in the Iron

a. RESIDUAL MAGNETISM has nothing to do with the field of the generator, it is the magnetism left in the iron after the magnetizing force has been withdrawn and can only be destroyed by extreme heat (700 C) or cold (—100 C). If the field rheostat is adjustable, I suggest that you cut resistance in and close the field switch, then gradually cut resistance out until the field builds up to the desired voltage. If the field switch is closed with all resistance cut out, the voltage may build up high enough to puncture the insulation if the latter should be weak. If the rheostat is not adjustable, start the generator with field switch closed and watch the voltage to see that it does not build up too high.

b. To clean the coils in the transformer, fill them with a caustic solution, let them stand for a while and then flush them out good with fresh water.

Vienna, Md. — W. R. PHILLIPS

He Says Oakite Will Clean Coils

I believe one of the answers to Question No. 238-b in the October issue of POWER PLANT ENGINEERING, would be the use of Oakite. I have personally used this material to clean the scale formed from hard water on condenser coils in evaporative condensers, and found it very satisfactory.

San Francisco, Calif. — E. C. SANFORD

Answer No. 239

Where Does the Engine Get All the Btu's?

Well, the thermo experts who heard our call for help on J. D. G.'s question in the October issue certainly have come through in fine style, although most of the comments did not come in until just a day or so after we sent the November issue to press. But since that time we've been swamped. We've got enough additional Btu's to last us all through the rest of the winter even if coal is rationed.

You remember that J. D. G. said he couldn't figure out what was happening in his engine taking throttle steam at 125 psi gage, 1193 Btu per pound and exhausting it at 5.2 psi gage, 1156 Btu per pound, and requiring 40 lb steam per kwhr. He said the engine only takes 37 Btu out of each pound of steam and $37 \times 40 = 1480$ — but there's 3413 Btu in a kwhr. How come?

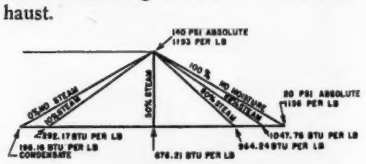
It was obvious, of course, that he was assuming dry saturated steam at both throttle and exhaust and forgetting that when steam expands in an engine it usually exhausts at a point below saturation—that is some of the steam condenses to water again at exhaust pressure, giving up its enthalpy of evaporation. That's where the Btu's come from.

True, it may be, as Walter Heidicker suggested in the November issue, that the exhaust is dry saturated but if so, then the steam admitted would have to be superheated to provide the additional Btu's. The question said nothing on this.

But since the idea of the exhaust containing moisture involves fundamental conception of expansion of steam in all engines and turbines, we wanted to bring it out fully. In the comments given, however, two distinctly different methods of analysis are given, resulting in different answers and involving two different methods of using the Mollier diagram. We have written for permission to reproduce a section of the Mollier diagram and in a future issue will endeavor to show just how the diagram and the steam tables should be used in analyzing a problem of this kind.

Missing Btu's Come from Moisture in Exhaust

J. D. G., in looking at the steam table, found the Btu content of 5 psi gage steam of 100 per cent quality, or steam that contains no moisture. This condition is never possible in exhaust from an engine, as some of the steam is condensed. When the steam contains some moisture, the quality will be less than 100 per cent, and the heat content will be less than that given in the steam table. To determine the Btu per pound of the exhaust, certain other figures from the steam tables must be used. The numeral one (1) after a property of the steam stands for the steam entering the engine, and the numeral two (2) stands for the exhaust. Steam conditions 140 lb absolute entering and 20 lb absolute exhaust.



This diagram by Ervin O. Schmoker may help to make clear the amount of heat given up by the steam as it condenses. The percentages are the percentages of steam in the mixture as the change takes place from a vapor to a liquid

$Sg_1 = 1.5751$
$Hg_1 = 1193$
$Sf_2 = .3356$
$Sfg_2 = 1.3962$
$Hf_2 = 196.16$
$Hfg_2 = 960.1$

Quality of the exhaust

$$\frac{Sg_1 - Sf_2}{Sfg_2} = \frac{1.5751 - .3356}{1.3962} = 0.887$$ or 88.7 per cent.

Btu per lb in exhaust

$Hf_2 + .887 \times Hfg_2 = 196.16 + .887 \times 960.1 = 1047.76$ Btu

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Btu used in engine per lb steam

$H_{g1} - 1047.76 = 1193 - 1047.76$

$= 145.24$ Btu.

Btu per kilowatthour

$145.24 \times 40 = 5809.6$ Btu

These figures show that each pound of exhaust steam contains only 1047.76 Btu instead of the 1156 given in the table and that each pound contains 11.3 per cent moisture.

Wilmette, Ill. ERVIN O. SCHMOKER

Ettelt Calculates Btu from Exhaust Moisture

ON QUESTION 239, the answer is found in the fact that saturated steam, when expanded from 125 psi gage to 5.2 psi gage is no longer saturated. Instead of 1156 Btu, as stated by J. D. G., it contains only about 1048 Btu at the end, according to the Mollier diagram. That is, in the work of expansion some of the steam has not only given up some of its sensible heat, but also latent heat, and therefore has returned to its original liquid state. This does not necessarily mean the state of California or New York, where you get any liquid around the corner, but one of the three states in which all matter exists; gaseous, liquid, solid.

Now the nice result is, that J. D. G. has about 12.3 per cent moisture in his exhaust steam, of which he needs 40 lb per kwhr. That gives him $40 \times (1198 - 1048)$ or some 5800 Btu per kwhr, or an efficiency of about 59 per cent.

Whenever he has the chance, he should obtain the Mollier Diagram and the Steam Tables by Keenan and Keyes and study it. The considerable brainwork it takes to comprehend that spider-web of curved and straight lines, called a diagram, does not however, require a college education. Once understood, this diagram turns out to be a mighty handy and frequently needed tool for the solution of most steam calculations.

Since we are, in this problem, dealing with Btu's per kwhr, not per hp-hr, we must consider the two components of the generating unit, namely the engine and the generator. The 59 per cent efficiency, arrived at, is the total efficiency of the whole unit. Assuming the electrical efficiency of the generator as 80 per cent, we have $0.59 \div 0.80$ or roughly 74 per cent engine efficiency. In order to find then the Btu's per engine horsepower, we multiply 2546 Btu (per theoretical hp-hr) by 100, and divide by 74. The result of about 3440 Btu per hp-hr is the amount of heat utilized by the engine to overcome its own various losses and to produce the power to drive the generator.

Brooklyn, N. Y. H. ETTELT

Calculations by Erisman

THE FALLACY in J. D. G.'s calculation is that he is not taking into consideration the quality or moisture content of the steam at the throttle and at the exhaust.

To know exactly the amount of Btu's absorbed per kwhr output, J. D. G. would have to use a calorimeter on both the throttle and exhaust steam.

Even if the steam at the throttle was dry saturated, each pound by weight of the 40 lb used, after expansion, would contain the heat of the liquid at the corresponding exhaust pressure, but only a part of each pound would contain the corresponding latent heat. The part not containing the latent heat would be water at the same temperature as the exhaust steam.

Therefore the total heat absorbed by the engine as useful work and the various losses such as bearing, friction, radiation, condensation, piston leakage and re-evaporation is equal to the following formula:

Total heat absorbed $= W\ (H_L + QH_{LA}) - (H_{L1} + Q_1\ H_{LA1})$ where

- W = weight of steam used
- H_L = heat of liquid at the corresponding throttle pressure and temperature
- Q = quality in per cent at the throttle
- H_{LA} = latent heat at the corresponding throttle pressure
- H_{L1} = heat of liquid at the corresponding exhaust pressure and temperature
- Q_1 = quality in per cent at the exhaust
- H_{LA1} = latent heat at the corresponding exhaust pressure

For a comparative basis, we can read the total heat and quality of the exhaust steam directly from a Mollier diagram, by assuming a perfect engine operating on the Rankin cycle in which all the heat energy absorbed is converted into work.

From the Mollier diagram, steam at 125 lb gage, dry saturated, expanding adiabatically to 5.2 lb gage will have a total heat of approximately 1050 Btu and a quality of approximately 88.9 per cent. This of course means that 11.1 per cent is water. This can readily be seen, since the total heat from the steam tables at 5.2 lb gage, dry saturated, is equal to approximately 1156 Btu. The heat of the liquid, from the steam tables, at 5.2 lb gage is approximately 195.5 Btu. Thus, only 854.5 Btu is left for latent heat. This part of the 1 lb of steam cannot, therefore, be steam at 5.2 lb gage. The quality, in per cent, is then equal to 100 times the quotient of 854.5 divided by the latent heat at 5.2 lb gage or

$$100 \frac{(854.5)}{(960.5)} = 89 \text{ per cent}$$

The total heat available from 1 lb would therefore equal 1193 minus 1050 or 143 Btu. The total heat available from 40 lb would equal 143 times 40 or 5720 Btu.

The weight of steam per kwhr of a perfect engine operating under the same throttle conditions as above would equal

$$\frac{3415}{143} \text{ or } 23.8 \text{ lb}$$

3415 equals the approximate Btu equivalent of 1 kw.

The difference between 40 and 223.8 lb or 16.2 lb is lost in J. D. G.'s engine in overcoming bearing friction, leakage, condensation, radiation, and re-evaporation, etc.

This gives his engine a Rankin efficiency based on electrical output equal to

$$100 \frac{(23.8)}{(40)} \text{ or } 59.5 \text{ per cent}$$

All the above illustrates why it pays to use steam expansively and I hope J. D. G.'s puzzle is cleared up.

St. Louis, Mo. JESSE L. ERISMAN

Calculations by Calvert

THE QUESTION is how many heat units are absorbed by a steam engine having a water rate of 40 lb per kwhr, supplied with steam at 125 psi gage and 1193 Btu per lb, and exhausting at 5.2 psi gage, an exact answer cannot be given from the above data.

For the purpose of illustrating the method for obtaining the heat drop, assume that the expansion is isentropic (constant entropy on the Mollier diagram). Observe that steam at 140 psi abs with a heat content of 1193 Btu per lb lies on the saturation line and is dry steam. From this point on the diagram (isentropically expanding the steam to exhaust pressure) drop vertically to the 20 lb constant pressure line. Note that the heat content of the steam is 1050 Btu per lb and that the per cent moisture is approximately 11 which means that the quality of the steam is 89 per cent. The theoretical heat drop is $1193 - 1050 = 143$ Btu per lb.

This heat drop is for a theoretical steam engine which converts all available heat (H, Btu in steam at throttle less h, Btu in steam at exhaust) into work without any losses (thermal or mechanical). A real steam engine cannot abstract all of the available heat (H-h) because of its losses and its heat drop is less than the theoretical heat drop.

The real heat drop can be found when the per cent moisture in the exhaust steam is known. Assume that the moisture was determined by means of a calorimeter and found to be 8 per cent. The total heat of the exhaust is 1079 Btu per lb as found at the intersection of the 20 psi abs constant pressure line with the 8 per cent moisture line on the Mollier diagram. The real heat drop is $1193 - 1079 = 114$ Btu per lb, the real heat rate is $40 \times 114 = 4560$ Btu per kwhr, and the unit overall thermal efficiency is $3415 \div 4560 = 75$ per cent.

Flushing, N. Y. JULIAN P. CALVERT

The Condition of the Exhaust Steam Will Reveal the Source of the Btu's

J. D. G.'s GOOD four valve steam engine-generator set taking steam at 125 psi gage and exhausting at 5.2 psi gage and operating on 40 lb of steam per kw hr is just an average engine. J. D. G.'s statement that the engine removes 37 Btu from each pound of steam as per his own admission certainly is an error. The trouble seems to be in the determination of the heat content of the exhaust steam. If the steam is initially dry and saturated there would be 1193 Btu per lb at the throttle and so much moisture in the exhaust steam that a throttling calorimeter could not be used and there may be difficulty in getting a fair sample for a condensing calorimeter because of the condensate. If J. D. G. assumes his exhaust steam to be dry and saturated, which of course cannot be, he will get from a Mollier chart 1156 Btu per lb. If he'll determine the exact condition and heat content, I believe he'll find the lost Btu's.

Rolla, Mo. AARON J. MILES

A COMPLETE LINE OF SPECIAL VALVES FOR SPECIAL SERVICES . . .

GOLDEN-ANDERSON *Specialty Valves*

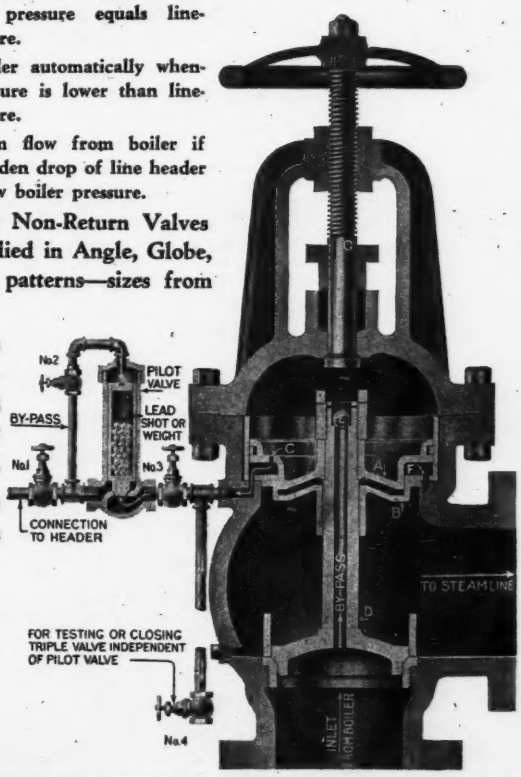
To insure that the valves you buy fit the service for which they are selected—specify GOLDEN-ANDERSON.

FOR EXAMPLE—here is the G-A Triple-Acting Non-Return Valve, capable of meeting any emergency caused by blown tubes or ruptured high pressure lines. This valve will—

- **—automatically cut in a boiler whenever boiler pressure equals line-header pressure.**
- **—isolate a boiler automatically whenever its pressure is lower than line-header pressure.**
- **—prevent steam flow from boiler if there is a sudden drop of line header pressure below boiler pressure.**

G-A Triple-Acting Non-Return Valves are regularly supplied in Angle, Globe, Cross and Elbow patterns—sizes from 2½" to 12".

Information on GOLDEN-ANDERSON'S *complete* line of Special Valves for Special Services is readily available . . . write today.



GOLDEN-ANDERSON VALVE SPECIALTY CO.

1300 FULTON BLDG. PITTSBURGH, PENNA.

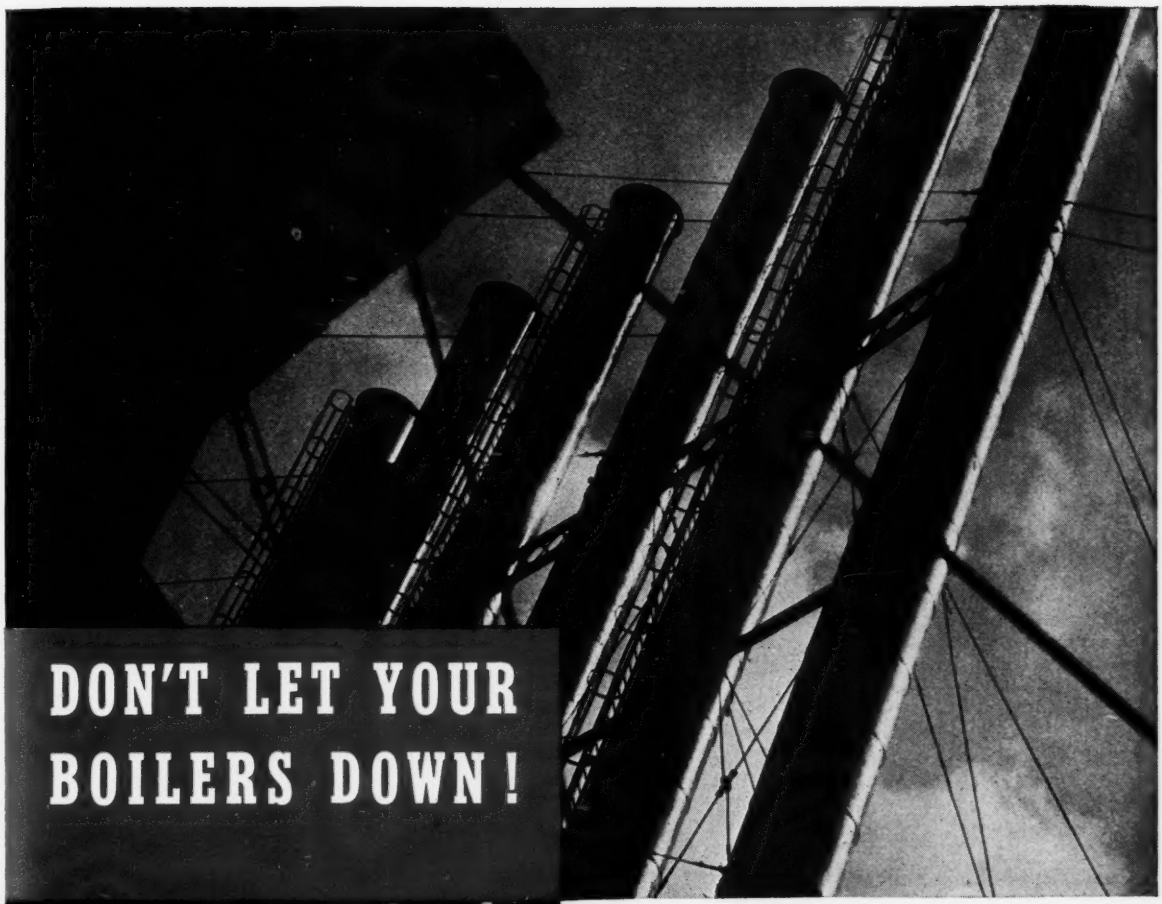
CHARACTERISTICS AND APPLICATIONS OF POLYPHASE AC MOTORS

Polyphase Type	*Ratings Hp*	*Speed Regulation*	*Speed Control*	*Starting Torque*	*Pull-out Torque*	*Applications*
General-purpose squirrel cage	0.5 to 200 hp	Drops about 3% for large to 5% for small sizes	None, except multi-speed types, designed for 2 to 4 fixed speeds	200% of full-load for 2-pole to 105% for 16-pole designs	200% of full-load	Constant-speed service where starting torque is not excessive. Fans, blowers, rotary compressors, centrifugal pumps, wood-working machines, machine tools, line shafts
Full-voltage starting, high stg torque, low stg current, squirrel cage	3 to 150 hp	Drops about 3% for large to 6% for small sizes	None, except multi-speed types, designed for 2 to 4 fixed speeds	250% of full-load for high-speed to 200% for low-speed designs	200% of full-load	Constant-speed service where fairly high starting torque is required at infrequent intervals with starting current of about 400% full load. Reciprocating pumps and compressors, conveyors, crushers pulvizers, agitators, etc
Full-voltage starting, high-stg torque, high-slip, squirrel cage	0.5 to 150 hp	Drops about 7 to 12% from no load to full load	None, except multi-speed types, designed for 2 to 4 fixed speeds	300 to 315% of full load, depending upon speed and rotor resistance	300%. This motor will usually not stall until loaded to its maximum torque, which occurs at standstill	Constant-speed service and high starting torque if starting not too frequent, and for taking high-peak loads with or without flywheels. Punch presses, die stamping, shears, bulldozers, bailers, hoists, cranes, elevators, etc
Wound-rotor, external-resistance starting	0.5 to several thousand	With rotor rings short-circuited, drops about 3% for large to 5% for small sizes	Speed can be reduced to 50% of normal by rotor resistance. Speed varies inversely as the load	Up to 300% depending upon external resistance in rotor circuit and how distributed	200% when rotor slip rings are short circuited	Where high starting torque with low-starting current or where limited speed control is required. Fans, centrifugal and plunger pumps, compressors, conveyors, hoists, cranes, ball mills, gate hoists, etc
Synchronous	25 to several thousand	Constant	None, except special motors designed for 2 fixed speeds	40% for slow-speed to 160% for medium speed 80% pf designs. Special high-torque designs	Unity-pf motors 170%; 80% = pf motors 225%. Special designs up to 300%	For constant-speed service, direct connection to slow-speed machines and where power-factor correction is required. For application see table, page 81

Characteristics* and Applications of D-c Motors, 1 to 300 Hp

Type	Starting Duty	Maximum Momentary Running Torque	Speed Regulation	Speed Control †	Applications
Shunt-wound, constant-speed	Medium starting torque. Varies with voltage supplied to armature, and is limited by starting resistor to 125 to 200 per cent full-load torque	125 to 200 per cent. Limited by commutation	8 to 12 per cent	Basic speed to 200 per cent basic speed by field control	Drives where starting requirements are not severe. Use constant-speed or adjustable-speed, depending on speed required. Centrifugal pumps, fans, blowers, conveyors, elevators, wood- and metal-working machines
Shunt-wound, adjustable-speed			10 to 20 per cent, increases with weak fields	Basic speed to 600 per cent basic speed (lower for some ratings) by field control	
Compound-wound, constant-speed	Heavy starting torque. Limited by starting resistor to 130 to 260 per cent of full-load torque	130 to 260 per cent. Limited by commutation	Standard compounding 25 per cent. Depends on amount of series winding	Basic speed to 125 per cent basic speed by field control	Drives requiring high starting torque and fairly constant speed. Pulsating loads. Shears, bending rolls, plunger pumps, conveyor crushers, etc.
Series-wound, varying-speed	Very heavy starting torque. Limited to 300 per cent to 350 per cent full-load torque	300 to 350 per cent. Limited by commutation	Very high. Infinite no-load speed	From zero to maximum speed, depending on control and load	Drives where very high starting torque is required and speed can be regulated. Cranes, hoists, gates, bridges, car dumpers, etc

* Table shows average values for standard motors.
† Minimum speed below basic speed by armature control limited by heating.



DON'T LET YOUR BOILERS DOWN!

Under wartime conditions, many boiler installations are working under an abnormal load, but they must continue to deliver with a minimum of time out for overhaul. Feed water that is exactly conditioned for your boilers will help reduce outage caused by corrosion, scale, embrittlement and carryover—will guard against costly failure.

Betz engineers and chemists know how to keep boilers operating 'round the clock. Years of experience with all types and sizes of installations and with widely varying feed waters enables Betz to render a boiler water service that is complete for all industries, with individual recommendations for each client.

Betz laboratories and engineers are located throughout the United States and Canada.

CHEMICAL ENGINEERS AND CONSULTANTS ON ALL WATER PROBLEMS

W. H. & L. D. BETZ

FRANKFORD · PHILADELPHIA · PENNA.

Joint Fuels Conference

(*Continued from Page 96*)

completely transformed into gas in the process. His paper, however, was confined to the use of producer gas in industrial furnaces so the data presented do not apply to power generation by gas engines. He gave the cost of gasifying one ton of coal or coke in his plant as $1.75 which may differ somewhat from other plants depending upon equipment size, labor charges and similar factors.

Not only is producer gas a cheap fuel but in Mr. Hendryx's opinion it is admirably adapted to many heating operations, particularly where a soft luminous flame is desired. It has a theoretical flame temperature of about 3100 F as compared to 3700 F for natural gas and 3800 F for oil. This makes it especially suited to steel reheating, where the entire furnace must be filled with a hazy, slightly reducing flame and hot spots must be avoided.

At the last session of the meeting J. F. Barkley of the U. S. Bureau of Mines, A. B. Hersberger of the Atlantic Refining Co. and L. R. Burdick of the Bureau of Mines gave a detailed report of their laboratory and field tests on coal-in-oil fuels. This work was undertaken to obtain needed practical information not found in technical literature, and was conducted jointly by the Federal Bureau of Mines and the Refining Co. of Philadelphia, Pa.

As the paper will be printed in abstract form in a forthcoming issue, it is sufficient to report here that results of the investigation show that coal-in-oil fuel has its own peculiar characteristics which must be given thorough consideration for each job if satisfaction is to be obtained. This fuel does not present a particularly difficult problem in devising equipment and operating routine for efficient use. It appears that in some instances premixing of the fuel might be eliminated. The direct introduction of the coal into the flowing stream of oil to the heater-pump set offers possibilities.

Fuel Trends

During the panel discussion on fuel trends it was noted that none of the speakers went so far as to make predictions regarding future fuels. The remarks were confined to present conditions and practices now employed to some extent at least. The opinion today seems general that production of both solid fuels and oil is problem number one with transportation a close second. A partial answer to both these problems is storage of fuel as far as this is possible, but it is quite evident that rationing will be resorted to if the production problem does not become better than it was at the time of the meeting.

The plants designed to burn gas, oil or solid fuels separately or simultaneously are in an enviable position today. The powdered fuel burner can readily be converted into a combination burner and give good combustion results without change of furnace dimensions if it is of common design. In some plants oil is being burned over the fuel bed in stokered furnaces to obtain higher capacity than can be secured with the stoker alone.

More efficient burning of all types of fuels is needed and may be demanded by the Government where users are definitely wasteful. Some think that natural gas as fuel will have a use restricted to certain industries and domestic purposes. Some gas fields are not developed but the known resources are definitely limited.

In the oil field, the big market is for gasoline with fuel oil as a by-product. It has been noted that the newer wells are producing oils with a larger percentage of the lighter oils and less of the fuel oils.

At the present moment, the overall supply of coal is sufficient, due to the stock piles that have been built up. Some localities, however, have difficulty in securing the kinds and sizes needed, principally because of the transportation problem. In many cases, substitutions must be made for the high grade fuels formerly used. The Diesel engine and gas turbine were suggested as possible means of improving railroad fuel problems of the future. Railroad locomotives, it was pointed out, cannot burn everything due to the many limitations encountered. It is an advantage for locomotives to go long periods without attention. Coal sizing is an advantage particularly when combustion rates as high as 200 lb per sq ft of grate surface are required. Briquetted coal has been used to advantage in locomotives.

Coke breeze, blast furnace gas and coal tar are fuels of which it is said industry has not taken full advantage.

The quality of coal being produced is going down continuously which necessitates more careful design of burning equipment that can be used efficiently with different types of coals and different kinds of fuel. Mixed coals may be an answer to some of the low fusion ash problems.

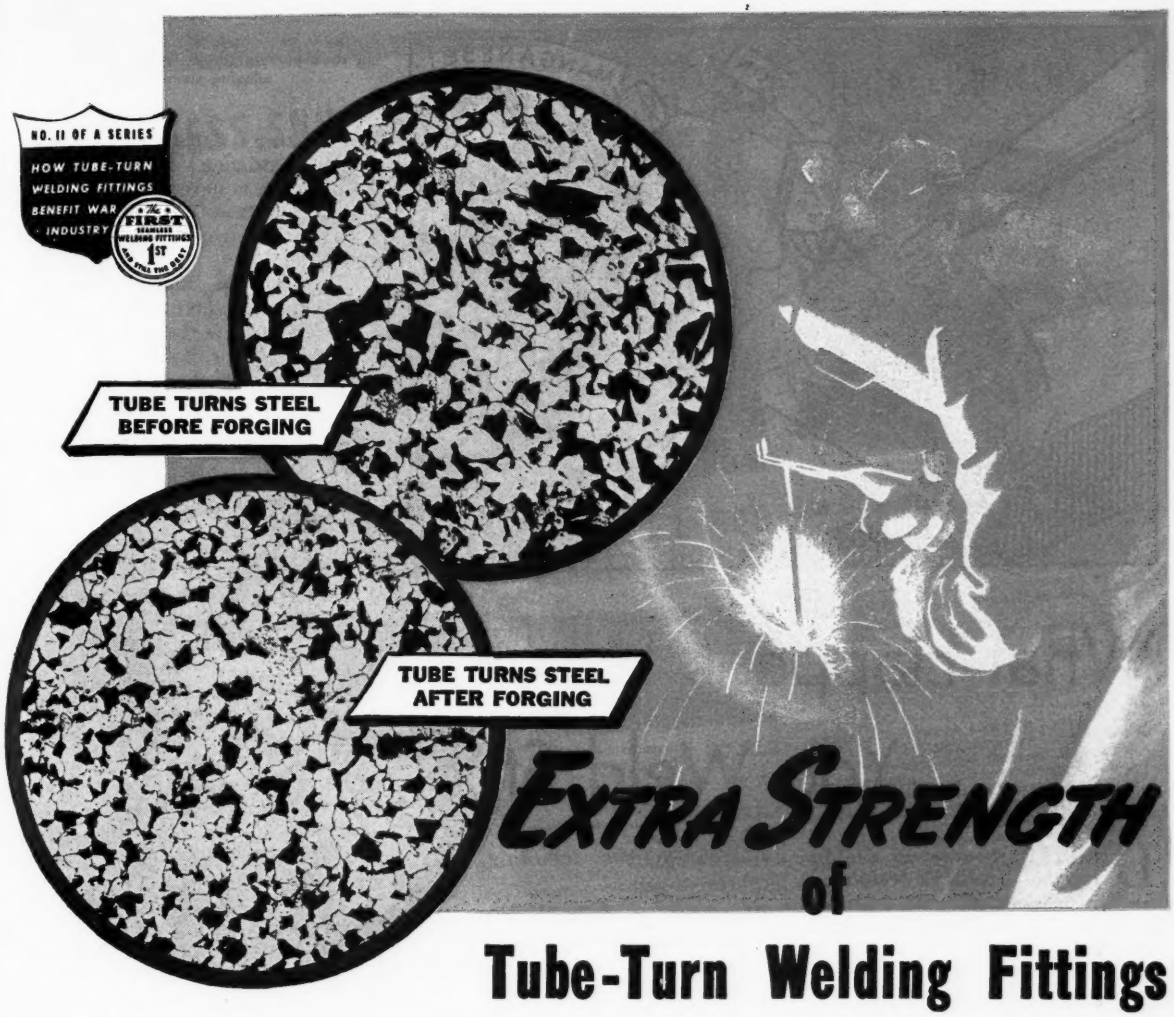
Anthracite production has dropped greatly in the past two years and the industry is endeavoring to stimulate the market by interesting manufacturers of gas and oil burning equipment to turn their attention to coal. Many of these manufacturers, it was pointed out, are dubious of the future of oil as a domestic fuel.

Kreisinger Given Award

For the second time the Joint Fuels Conference presented the Percy Nicholls Award "for notable scientific or industrial achievement in the field of solid fuels." This year the recipient chosen was Henry Kreisinger. "His contribution to the organized study of the coals of the United States and his research in the utilization of solid fuels have helped greatly in the development of the science of fuel technology," said the citation.

Born in Czechoslovakia in 1876 and naturalized as a United States citizen in Chicago in 1898, Mr. Kreisinger received his higher formal education at the University of Illinois following which he was associated with the U. S. Geological Survey, the Clinchfield Fuel Co., the U. S. Bureau of Mines and in recent years with Combustion Engineering Co.

In accepting the award Mr. Kreisinger expressed appreciation of the honor conferred upon him and remarked, "I have reached an age when a man begins to look back on his life and wonders whether he has made the best of his opportunities. During such moments it will give me much satisfaction to know that there are men who think that I have done something worth while in my life." He then outlined how, some forty years ago, organized study of coals was started and the progress that has been made since, closing with the statement that "when we wish to form an opinion about the suitability of a given coal for a given coal-burning equipment, we desire to have not only the chemical composition and heat value of the coal but also the fusion temperature and perhaps the composition of the ash."


NO. II OF A SERIES
HOW TUBE-TURN WELDING FITTINGS BENEFIT WAR INDUSTRY
The FIRST SEAMLESS WELDING FITTINGS 1ST AND STILL THE BEST
TUBE TURNS STEEL BEFORE FORGING
TUBE TURNS STEEL AFTER FORGING

EXTRA STRENGTH of Tube-Turn Welding Fittings prolongs piping service under wartime demands!

URGENT three-shift war plant schedules demand uninterrupted piping service—yet they impose triple duty on vital piping arteries. Fittings and joints bear the brunt of this wear and strain.

Tube Turns' exclusive manufacturing process actually improves on the top quality seamless steel tubing from which these fittings are forged. Proof lies in the 100X photomicrographs shown here. The finer grain quality in the Tube Turns metal structure guarantees the added strength and greater resistance to wear and corrosion. Even *better* proof lies in the long, unfailing service Tube-Turn Welding Fittings are rendering in thousands of war plants today.

TUBE TURNS (Inc.) Louisville, Ky. *Branch Offices:* New York, Chicago, Philadelphia, Pittsburgh, Cleveland, Dayton, Washington, D. C., Houston, San Francisco, Seattle. . . . . *Distributors located in principal cities.*

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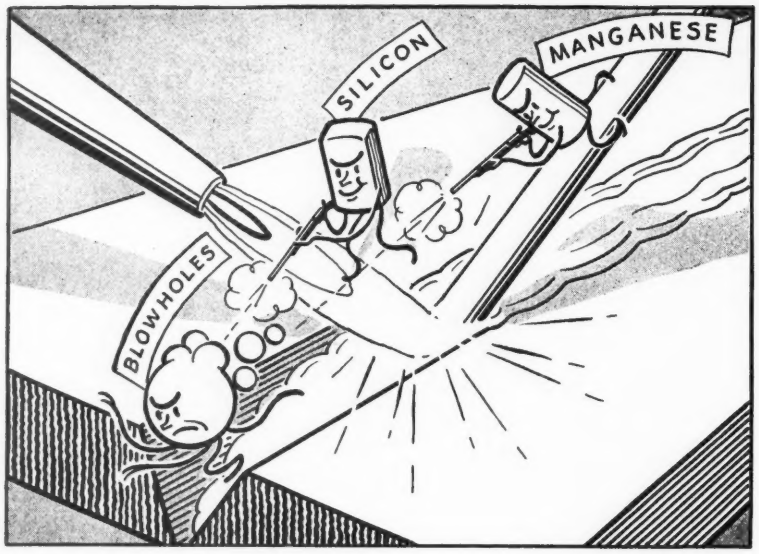
Welding Fittings and Flanges



Blowholes are largely eliminated when welding rods contain silicon and manganese as alloying elements

What Happens When You Weld Steel

DESPITE its seeming simplicity the process of welding is one which involves rapid and complex chemical and physical actions and reactions. Most experienced welding operators know that when steel is heated to a melting temperature and cooled, as in welding, it undergoes certain changes. These changes may include a gas-producing reaction between certain elements in the molten steel, formation of scale on the surface, over-all expansion and contraction and changes in the grain structure. By understanding the nature of these changes, however, and by using correct welding procedures and materials, the welding operator can readily protect the steel from any harmful effects of these changes or reduce them to a satisfactory minimum.

The actions and reactions that take place when steel is welded were recounted in a very interesting way by P. E. Timmerman of The Linde Air Products Co. recently in an issue of The Welding Engineer from which the material, including the amusing little drawings, presented here, was abstracted.

Each of the important factors that contribute to a good knowledge of welding as set forth in Mr. Timmerman's discussion are considered in the following paragraphs.

Alloying Elements in Welding Rods

High-strength steel welding rods contain silicon and manganese. By the addition of these elements, the gas-forming reaction between iron oxide and carbon that would occur during welding is minimized and is replaced by a reaction between iron oxide and the silicon and manganese in the rod. Since the products of this reaction are solids rather than gases, they do not produce blowholes. Instead, when there is a proper relation between the silicon and the manganese contents of the rod, these solids produce a fluid slag which will float to the surface of the metal during welding, effectively cleaning the weld metal as it does so and helping to blanket it against further oxidation from oxygen in the air. Eliminating the causes of carbon-iron oxide reactions in this manner makes it possible to increase the carbon content of the rod safely, and thus obtain stronger and sounder welds.

The Welding Flame

By varying the amounts of oxygen and acetylene that are supplied to the welding flame, three different types of flames can be produced: a neutral flame, an excess acetylene (carburizing) flame or an excess oxygen (oxidizing) flame. The oxidizing flame is never used in welding steel because it promotes the formation of iron oxide, which is undesirable.

The neutral flame—produced by a balanced mixture of oxygen and acetylene—is the flame usually employed, since it has the least effect upon the chemical composition of the weld metal. Like the floating slag on top of the molten metal, it serves to shut out the oxygen of the surrounding air.

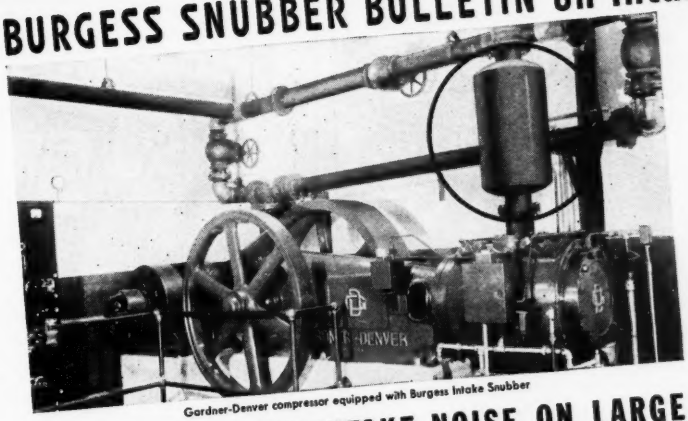
The excess acetylene flame is also used because of the development of the special technique of welding in which the welding flame performs an added function over the usual preheating of the base metal and melting of the rod. This welding method depends for its effectiveness upon the fact that the carbon in the excess acetylene flame effectively reduces any iron oxide on the surface of the steel, leaving a type of iron which absorbs carbon from the flame. By increasing the carbon content of the steel in this manner, its melting point is correspondingly lowered.

In the above method the flame is directed backward over the completed weld, but in such a way that it also touches the scarf or vee in advance of the welding puddle. The procedure thus serves to remove rapidly the gas-producing oxide scale in advance of the welding puddle, and to bring the highly carburized, low-melting-point surface of the scarf easily to a "wetting" condition, which is ideal for forming a union between liquid metal from the rod and the base metal. The highly carburized surface of the scarf is rapidly absorbed by the added metal and the carbon diffused through the weld, giving a uniformly strong ductile weld.

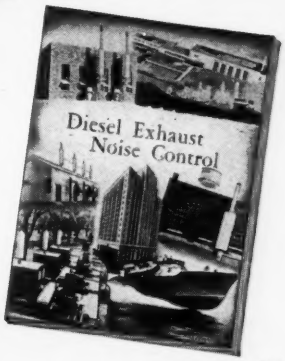
Expansion and Contraction

The simplest phenomenon that happens to solid steel is, of course, expansion. At the time that it is expanding, the steel becomes increasingly soft, ductile and weak, a fact that presents both advantages and disadvantages. As an advantage, stresses in the steel are relieved because of the ease with which the steel can stretch and yield. This is particularly true in oxy-acetylene welding, where a considerable area is heated at one time.

BURGESS SNUBBER BULLETIN on Intake Noise Control



Gardner-Denver compressor equipped with Burgess Intake Snubber



HOW TO PREVENT INTAKE NOISE ON LARGE COMPRESSORS OR PUMP-SCAVENGED ENGINES

Intake air noises are as obnoxious as exhaust noises. Unless intake noise is quieted, it is heard as a high-pitched tone or objectionable whine. Pulsating air waves are also produced which may cause a disagreeable vibration nuisance. Each intake silencing problem must therefore be considered individually because there are few general rules which fit all cases.

Where the noise level must be reduced only to the noise level of the engine room or surroundings, a Burgess Intake Cleaner-Silencer can be used on large compressors or pump-scavenged engines. Silencing is

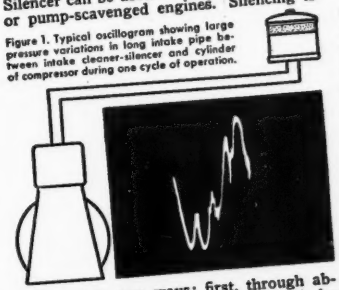


Figure 1. Typical oscillogram showing large pressure variations in long intake pipe between intake cleaner-silencer and cylinder of compressor during one cycle of operation.

obtained in two ways: first, through absorption of the high frequency sounds by the patented Burgess acoustic construction; and second, by suppressing low frequency sounds with acoustic reactance chambers. Resistance to air flow is extremely low—no greater than the entrance loss for the pipe alone.

Intake Cleaner-Silencers must never be mounted at the end of a long intake pipe but always directly on the compressor or engine. Figure 1 is an oscillogram illustrating the fluctuating pressure conditions in a long intake pipe between the cylinder of a compressor and an intake Cleaner-Silencer during one cycle of operation. The bottom part of the curve shows the first half of the cycle when the air is flowing into the intake pipe to the compressor. The top part shows the second half of the cycle while the air is flowing out of the pipe.

When the intake valve is opened, there is an immediate inrush surge of air through the pipe and into the cylinder, followed by a negative pressure or vacuum and then

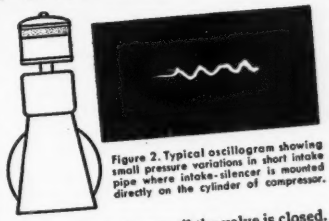


Figure 2. Typical oscillogram showing small pressure variations in short intake pipe where intake-silencer is mounted directly on the cylinder of compressor.

smaller oscillations until the valve is closed. The air then piles up against the closed valve until a relatively high pressure is built up in the pipe. When the pressure is high enough to overcome the momentum of the incoming air, the air inrush is stopped and the built-up pressure forces the air violently out of the pipe. The silencer must handle much more air than the compressor size would indicate. Air goes through the silencer when the intake valve is open and some of it is forced back out as the valve is closed. Handling the air forced back overloads the silencer. The high peaks in the oscillogram show the wide range of pressure as the air surges back and forth in the intake pipe. The *important point* is that the accelerated pulsations may become so strong that the silencer will be damaged.

Figure 2 shows the much smaller pulsations which occur when a very short pipe is used between the silencer and the cylinder. The intake air is smoothed out to an even flow enabling the Cleaner-Silencer to operate efficiently without the possibility of mechanical failure from violent pulsations in the intake pipe.

Where complete quieting of intake air is required, Burgess Intake Snubbers are recommended. They remove the cause of the noise before the noise can occur. Incoming pulses of air are snubbed or checked so that the oscillating flow of intake air, which causes "pumping" noise, is smoothed to a unidirectional flow. Vibration is eliminated and the flow of air into engine or compressor is smooth and quiet. No tuning of the system is necessary for Burgess Intake Snubbers will prevent intake noise, regardless of the position or location of the Snubber in the intake system.

New Booklet of Usable Facts "Diesel Exhaust Noise Control"

This new booklet describes how quiet exhausts will make Diesel engines acceptable for many types of applications such as hospitals, office buildings, hotels, municipal and industrial plants, boats of all kinds, Diesel trains, and other uses where noise would be intolerable. It is full of information that is helpful to Diesel operators and engineers everywhere. There is a wide variety of Snubber applications to suggest what can be done in installing Diesel power in any location, however strict the local regulations or ordinances regarding noise may be. They show how Burgess Exhaust Snubbers make it possible to operate Diesel engines in the most critical locations. Dozens of pictures, charts, graphs, "right" and "wrong" illustrations, "Helpful Hints," make this booklet easy to use and understand. We shall be glad to send you a copy upon request. Ask for Bulletin 447.

HELPFUL HINTS

Use only light oil or kerosene to wash filter elements

Since the purpose of intake air cleaners is to reduce maintenance, filter elements should be cleaned and charged at regular intervals, which will vary from two to six weeks under normal conditions. They can be cleaned very easily by washing in kerosene or light oil. After they have drained thoroughly they can be dipped in oil to give them the viscous coating which catches dirt and grit. Use SAE 40-50 oil for air temperatures of 60° F. and above, SAE 20 oil for air temperatures below 60° F. CAUTION: Do not use a caustic solution for washing, as it will eat away the filter element and make it brittle, destroying its efficiency.

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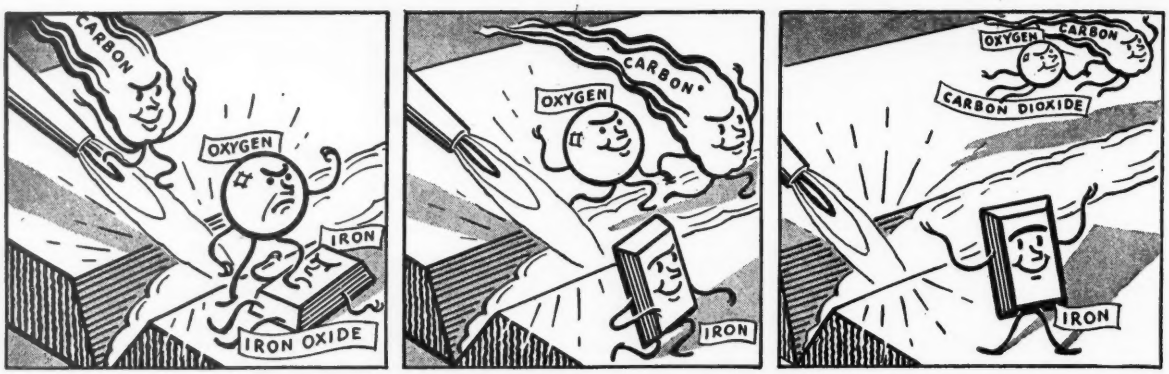


The carbon in an excess acetylene flame effectively removes oxygen from any iron oxide that may be present in the surface of the steel

On the other hand, the low strength of the steel at high temperatures makes it necessary to be sure that the part is free to move so that an undue load is not placed on the hot steel. For this reason, welding jigs should be more positioning and supporting devices than rigid clamps. Particular attention also should be paid to final welds of a closed structure to prevent locking up of stresses in the structure that in extreme instances might rupture the metal. Preheating is often helpful to spread the heat over large areas or to compensate for differences in mass of the parts being joined.

Effect of Heating and Cooling

In general, welded parts should be allowed to cool slowly for the following reasons. When plain carbon steel is heated to a temperature in the neighborhood of 1600 deg. F., depending upon the carbon content of the steel, it undergoes a change of the utmost importance. At this bright red temperature, the carbon in steel, which at a lower temperature has existed as particles of iron carbide mixed throughout the pure iron, goes into solid solution with the iron. On slow cooling down through this temperature, the carbon is again precipitated or thrown out of solution as iron carbide. The manner in which the precipitation takes place and hence the condition of the steel at lower temperatures is profoundly affected by the rate at which cooling takes place. When rapidly cooled the steel is left in a relatively hard and brittle condition, whereas when it is slowly cooled through this temperature, it is soft and ductile.

There is another metallurgical change which takes place at about the same temperature. When heated much above 1600 deg. F. again, depending upon the carbon content of the steel, the grains tend to grow in size—the size depending primarily on the temperature to which the steel is raised and also on the length of time that it is held at that temperature. If, however, the temperature is raised to just above this point and the time kept short, small grains will be formed, a condition that generally produces superior physical properties.

World's Most Powerful Motor

THE MOST POWERFUL electric motor in the world — powerful enough to hoist a destroyer completely out of the water and up to the height of a 15-story building, all in a minute's time—has recently been completed at General Electric's Schenectady, N. Y., plant for shipment to the new Geneva, Utah, steel mill financed and owned by Defense Plant Corp. and to be operated by the Geneva Steel Co. A view of this motor is shown on the cover of this issue.

By applying its 7000 hp at the comparatively low shaft speed of 25 rpm this giant direct-current motor will develop more turning power than any other motor, either alternating or direct current, ever built. It will operate the reversing rougher of a plate mill which will produce steel plates from a slab weighing as much as 20,000 lb for shipyards and war industry.

The maximum turning power of the motor, which is two and three-quarters times the rated 7000 hp. is more than four million lb-ft. If a rope could be wound around the shaft it could lift a weight of 1350 tons, which is approximately the weight of one of the four-stack destroyers which the United States traded to Great Britain. The motor could lift this weight at the rate of 200 fpm, the approximate height of a 15-story building.

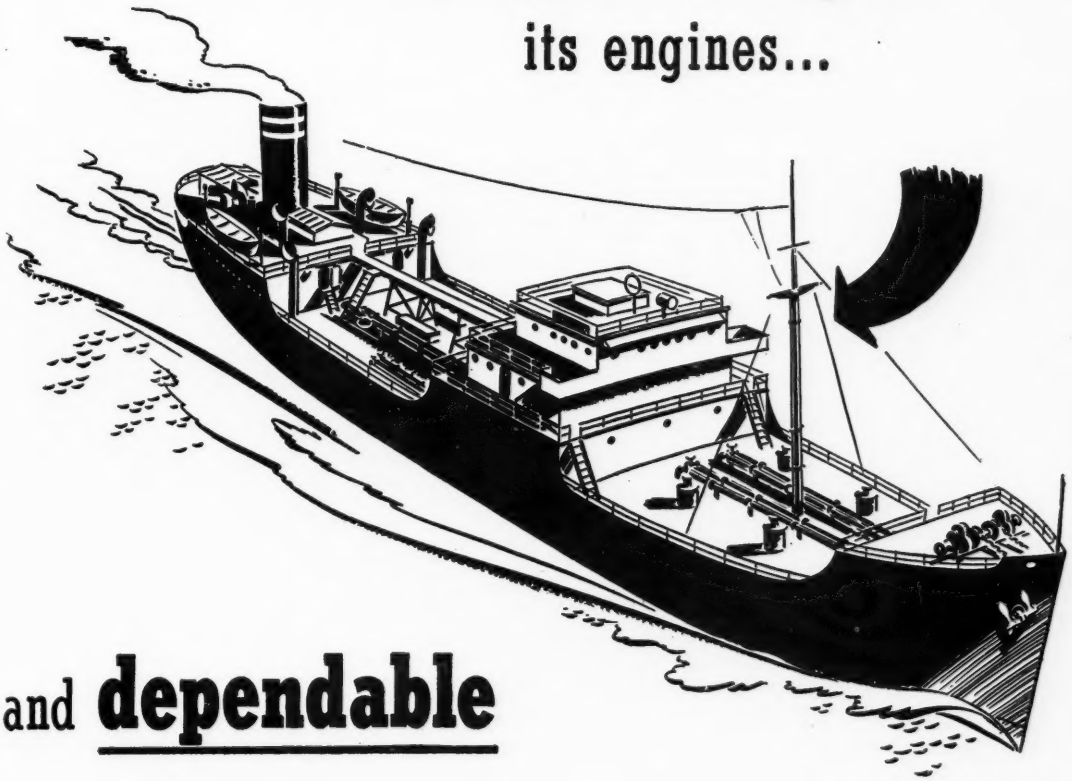
The motor has an over-all length of 44 ft, an outside diameter of 16 ft, and weighs nearly a million pounds; when installed, it will stand 13 ft above the floor level. An unusual feature is the absence of the continuous shaft found in most large motors. Instead, the two 3500-hp rotors are built up on hollow cylindrical bodies, coupled together at the center, and provided with flanges at the ends. To these flanges are securely bolted shafts of sufficient size to support the rotor in its bearings and transmit the driving power. This arrangement saves time in erection; also, since this "hollow shaft" construction is more rigid than a solid shaft, the whole rotor structure is much lighter for the same strength, resulting in an important saving in weight of steel required. Nine freight cars will be needed in shipment.

The motor will be powered by a 7000 kw, six-unit flywheel motor-generator set which has already been shipped from the G-E plant in Schenectady.

The motor will drive the reversing rougher of a 132-in. semicontinuous plate mill, capable of rolling steel plate in both directions. Slabs six to eight inches thick and 60 in. wide will be fed into the mill and will emerge one-fourth to three-fourths of an inch thick and up to 127 in. wide. One-fourth in. plate would weigh approximately 20,000 lb and be approximately 200 ft long.

The Geneva steel mill, which will be one of the largest in operation west of the Mississippi River, will supply plate to west coast shipyards and war plants.

The heart of a ship is its engines...



and **dependable**

Diesel Engines are built by

BALDWIN

On the shoulders of the captain and the chief engineer, rest the responsibility of maintaining schedules. And the performance of a ship's engines has much to do with the efficiency of operations. When a ship is loaded, it must be ready to go. Its engines must respond to the signal from the bridge.

Known throughout the country for their dependable and economical operations, Baldwin Diesels are a ship's best insurance for uninterrupted power supply. They can be operated with very low costs for maintenance and repairs.

Whatever your Diesel requirements are—prime or auxiliary power—you can save money with a Baldwin. They range in size from 200 bhp to 1,500 bhp. A Baldwin engineer will be glad to call, investigate your power needs and problems. No obligation. Write for the latest technical bulletin. The Baldwin Locomotive Works, Philadelphia.

BLW THE BALDWIN GROUP **BALDWIN**
DIESEL ENGINES

BUILDERS OF DEPENDABLE ENGINES SINCE 1880

Our Dwindling Oil Resources

FOR THE FIRST time in the history of our country some concern is being shown regarding our oil resources. True, the subject received some attention as far back as twenty years ago but subsequent discoveries of new fields dispelled the rather dire predictions that had been made and so the average American got the impression that our oil resources were virtually inexhaustible, despite repeated warnings to the contrary from time to time. Recently, however, the warnings have become more emphatic and one has only to examine the figures showing the rate of new discoveries to realize that perhaps these warnings, this time, mean something. Several articles on the subject have appeared recently but one of the most authoritative discussions of the subject appeared in a recent issue of the Arthur D. Little Industrial Bulletin. As this discussion points out, opinions differ widely, and it is stimulating to find expressions like those of Dr. Benjamin Brooks of concern about the seriousness of shortages in effect rebutted by statements of Dr. Gustav Egloff.

Despite the still plentiful supply of petroleum, since the mid-thirties the rate of finding new oil falls far short of our consumption and as a result, we are now drawing upon our reserves. Unless these trends are reversed our prospects are for more expensive oil, partially imported, for more careful use, and ultimately for liquid fuels from non-petroleum sources such as coal and tar sands.

During 1934 to 1938, new oil reserves were discovered at the average rate of 2000 million barrels per year. During this period the size of the average new field decreased from 19.7 million barrels to 11.4 million barrels, but the increased number of fields found maintained the rate of total discovery. After 1937, however, the rate of new discoveries decreased markedly, from somewhat over 900 million barrels of ultimately producible oil found in that year to 400 million found in 1941 and 250 million in 1942. During this period the size of new fields continued to decline, from 5.6 million barrels in 1939 to 1.2 in 1942, and greater numbers of new fields, to maintain the rate of discoveries at the level of the early thirties, could not be found. Most of the decline in rate of discovery came before the war imposed difficulties on random exploratory drilling.

Current Discoveries

The current rate of discovery, 250 million barrels in 1942, compares with a prewar consumption rate of about 1250 million barrels per year and a current wartime rate of 1400 million barrels. Even today's restricted civilian consumption is greater than the rate of new discoveries. Except for a few locations, every field in the nation is now producing at or in excess of its maximum efficient capacity and must continue to do so to meet wartime demand. Estimates of our present petroleum reserves are based on the assumption of a production rate below these maxima. It is feared that damage caused by this overproduction may offset any possible upward revision in our reserves based on more precise knowledge of established fields.

Estimation of our ultimate oil supplies is a controversial question, since some big new discovery often vitiates predictions based on past statistics. However, the more oil is discovered, the less is left for discovery; and since the total amount available is fixed, within the human scale of time, the limits of discovery in the nature of things will inevitably be reached at some time.

The falling rate of discoveries is due to the growing difficulty of finding new geologic traps for oil. Obvious and easily mapped structures have been drilled and most of the shallow prospects have been tested by drilling. The remaining undiscovered reserves are thus largely either in regions not yet explored because of unpromising prospects, in reservoirs deeper than those already reached in producing structure, or in reservoirs without surface of geophysically detected identification. In the ultimate sense only those regions composed entirely of underlying igneous rock formations can be considered without prospect of having oil, but in a practical sense there are other limitations.

Wildcat Drilling

Discovery of reservoirs without surface identification must depend upon random wildcat drilling. In 1940 about one wildcat well in twenty drilled at random was successful, whereas one well in five drilled on prospects developed by technical methods produced oil. Deeper drilling is finding some oil, the deepest present producer, in Louisiana, being over 2.5 miles.

While there always remains the possibility that some very large field may be discovered, such as that in East Texas, the uncertainty of such happening increases as more and more territory is explored with only minor fields being discovered. The best possibility seems to be that deeper exploration may discover some rich producing zones.

The declining rate of discovery has persisted in spite of continued reinvestment of capital in maintaining the supply of petroleum. Thus, in the eight-year interval, 1934-1941, based on figures for 30 oil companies, an average of 60 per cent of funds invested in fixed capital assets went into the producing branch of the industry, as compared with 40 per cent invested in all other branches. For these 30 companies about 55 cents was invested in producing facilities for every barrel of oil produced in this interval. A barrel of oil is currently worth about $1.25.

Future Supplies

For the immediate future, imports from Venezuela and Mexico will probably make up any domestic deficit, with the cost rising as rapidly as the traffic will bear. As the source of imports extends beyond this hemisphere, increasing buying competition will be met from other nations. Production has not reached a peak in Russia, Venezuela, Iran, the East Indies, Mexico, Iraq, Colombia, Bahrein Islands and South Arabia. The reserves of Russia, Iraq and Iran are believed to be relatively unexploited. Thus, prewar production of Russia, Venezuela and Iran, the three largest foreign producers, together amounted to about the production from the State of Texas.

In the petroleum industry, the changed position of the United States would appear to favor the large enterprises with control of foreign fields and transportation means. Coastal refineries would benefit more from imports. What is probably of greater importance to the consumer, it will be economically sound to spend more money in converting the costly petroleum into useful products either for the purpose of effecting higher conversions, of getting more valuable products, or both. The unit price to the consumer may be expected to rise, but the cost of unit performance need not follow, since better products, especially motor fuel, will give enhanced performance.

COPES
FEED WATER
REGULATORS
Made in several types for simple level control, and for steam-flow water-level control. Every Copes Regulator is designed for the boiler it serves, and utilizes the famous Copes Thermostat as the water level responsive device.
Over 65,000 in World Service
Copes Reducing Valves for close control of reduced fluid pressures.
Copes Desuperheaters—self-contained units of the spray type.
Copes Pumping Units—dependable source of hydraulic pressure for relay operated valves or controls.
Copes Balanced Valves—closely balanced, low friction valves for any flow control application, actuated by any power device.
Copes Pump Governors for excess pressure control in boiler feeding.
COPES

THESE COPES PRODUCTS *offer you better results*

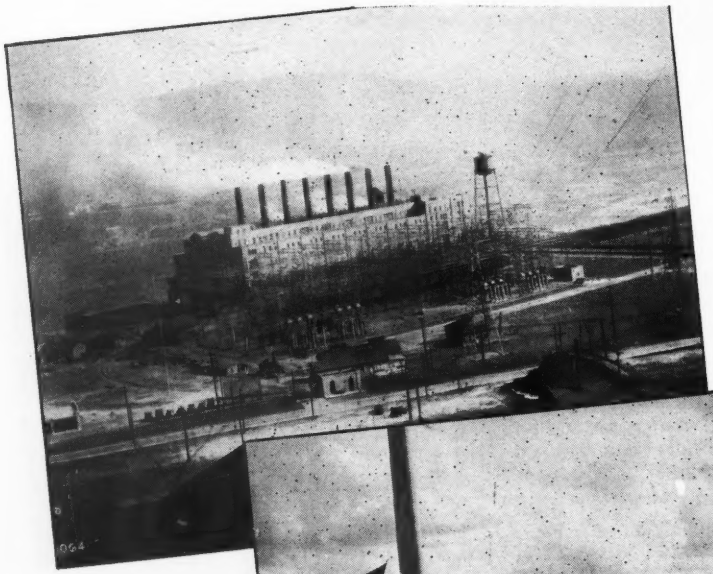
Each of the Copes Products illustrated above, incorporates important features not ordinarily available. Each is designed and built to do a thorough job—dependably, with little maintenance. Each is "tailored" to individual requirements—your guarantee that it will best fit the conditions.

Your Copes Product is not forgotten when it leaves our factory. By means of a follow-up system and inspection by Copes Engineering Representatives, we make certain that your equipment is performing at its best.

It pays to specify Copes. For further details, write us today outlining your problems.

COPES FEED WATER REGULATORS AND ALLIED EQUIPMENT

NORTHERN EQUIPMENT COMPANY · 1232 GROVE DRIVE, ERIE, PA.



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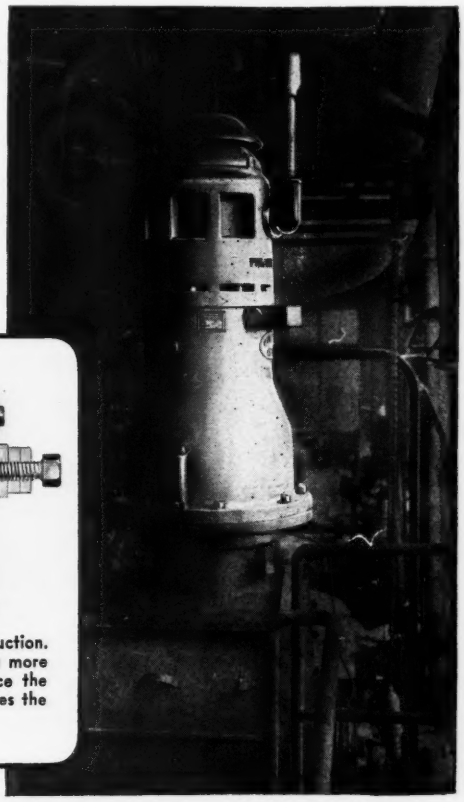
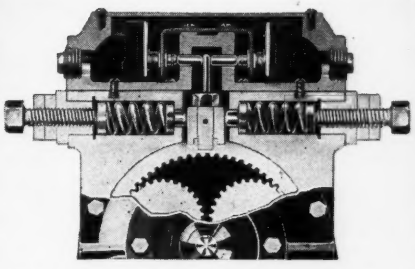
OVERLOADING CAN'T DAMAGE EQUIPMENT DRIVEN WITH THE PLANETORQUE-MOTOREDUCER





Cut-away view showing internal construction. PlaneTorque switch responds to overloads more quickly than electrical thermal relays since the mechanical action of the overload operates the cut out switch directly.

The PlaneTorque safety feature of this self-contained drive automatically and instantly shuts-off power whenever a predetermined load limit is reached. This makes it ideal for driving stokers, conveyors, mixers and other equipment that may become jammed or overloaded.

The MotoReduceR with this feature can be had in both horizontal or vertical types in a wide range of ratios and horsepowers.

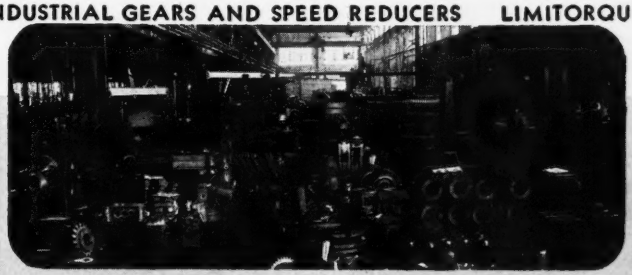
Our catalog M R 40 will give all the facts. Send for a copy.

ARMY E NAVY

PHILADELPHIA GEAR WORKS, INC.

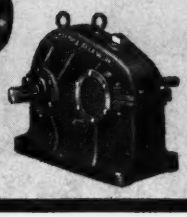
INDUSTRIAL GEARS AND SPEED REDUCERS LIMITORQUE VALVE CONTROLS

ERIE AVENUE & G STREET
PHILADELPHIA 34, PENNA.
NEW YORK, PITTSBURGH, CHICAGO

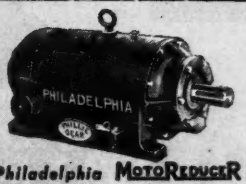


Philadelphia LIMITORQUE CONTROL operates all types of valves, etc., safely, economically, from convenient stations.

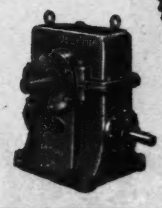
Philadelphia GEARS All types and sizes of industrial gears. Can be supplied in all materials.



Philadelphia HERRINGBONE SPEED REDUCER for heavy loads at high speed. Single, Double, Triple Reductions, various ratios and horsepowers.



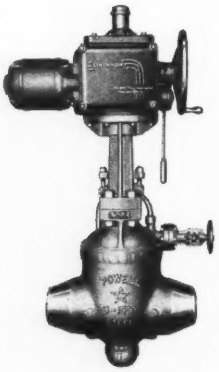
Philadelphia MOTOREDUCER The economical self-contained drive, Horizontal or Vertical types — various ratios and horsepowers.



Philadelphia WORM GEAR SPEED REDUCER right angle drives — vertical or horizontal. Wide range of ratios and horsepowers.

Ask POWELL for the Answer to all your VALVE requirements

Ask POWELL for the Answer to all your VALVE requirements
THE WM. POWELL CO.
Dependable Valves Since 1846
CINCINNATI 22, OHIO



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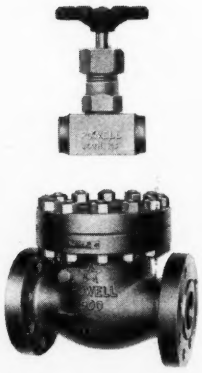

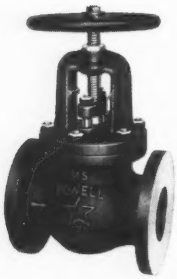

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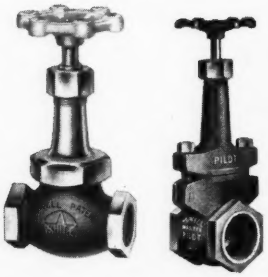

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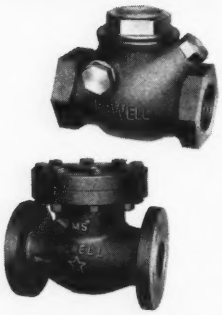

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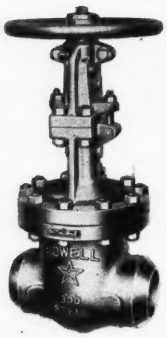

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THE WM. POWELL CO.
Dependable Valves Since 1846
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A Gold Star, to be added to our Maritime "M" Pennant, has just been awarded us for continued meritorious production performance during the last six months.

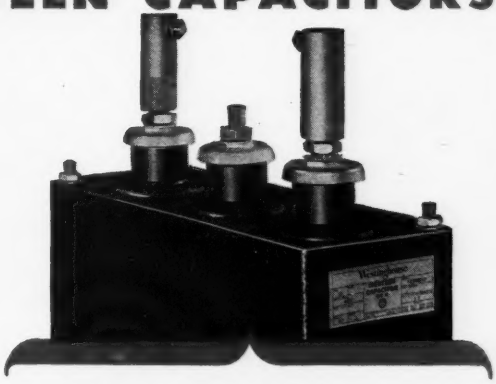
POWELL VALVES

QUICK RELIEF for overloaded systems... with Westinghouse INERTEEN CAPACITORS

Relief for overloaded systems doesn't necessarily call for more lines and equipment. Where part of the overloaded condition is due to low power factor caused by inductive loads, the cure is quick and simple—Westinghouse Inerteen Capacitors.

By improving power factor, Inerteen Capacitors relieve lines and equipment of "dead-head" current, and quickly release capacity for useful power. All-around system performance is measurably improved. Installation is simply a matter of installing capacitors at the substation or on the distribution circuits.

To relieve feeder problems, and wherever industrial customers have a heavy inductive load that is taxing present lines and equipment, recommend Westinghouse Inerteen Capacitors. For more information, call your nearest Westinghouse Office or write Westinghouse Electric & Manufacturing Co., East Pittsburgh, Pa., Dept. 7-N. J-60534



ONE-THIRD TO ⅔ KV-A OF LOAD-CARRYING CAPACITY IS RELEASED BY EACH CAPACITOR KV-A INSTALLED

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FOR EXAMPLE: One utility provided 6,000 additional kv-a of power for a new tank plant by installing 15,000 kv-a of capacitors.

Westinghouse

PLANTS IN 25 CITIES... OFFICES EVERYWHERE

INERTEEN CAPACITORS

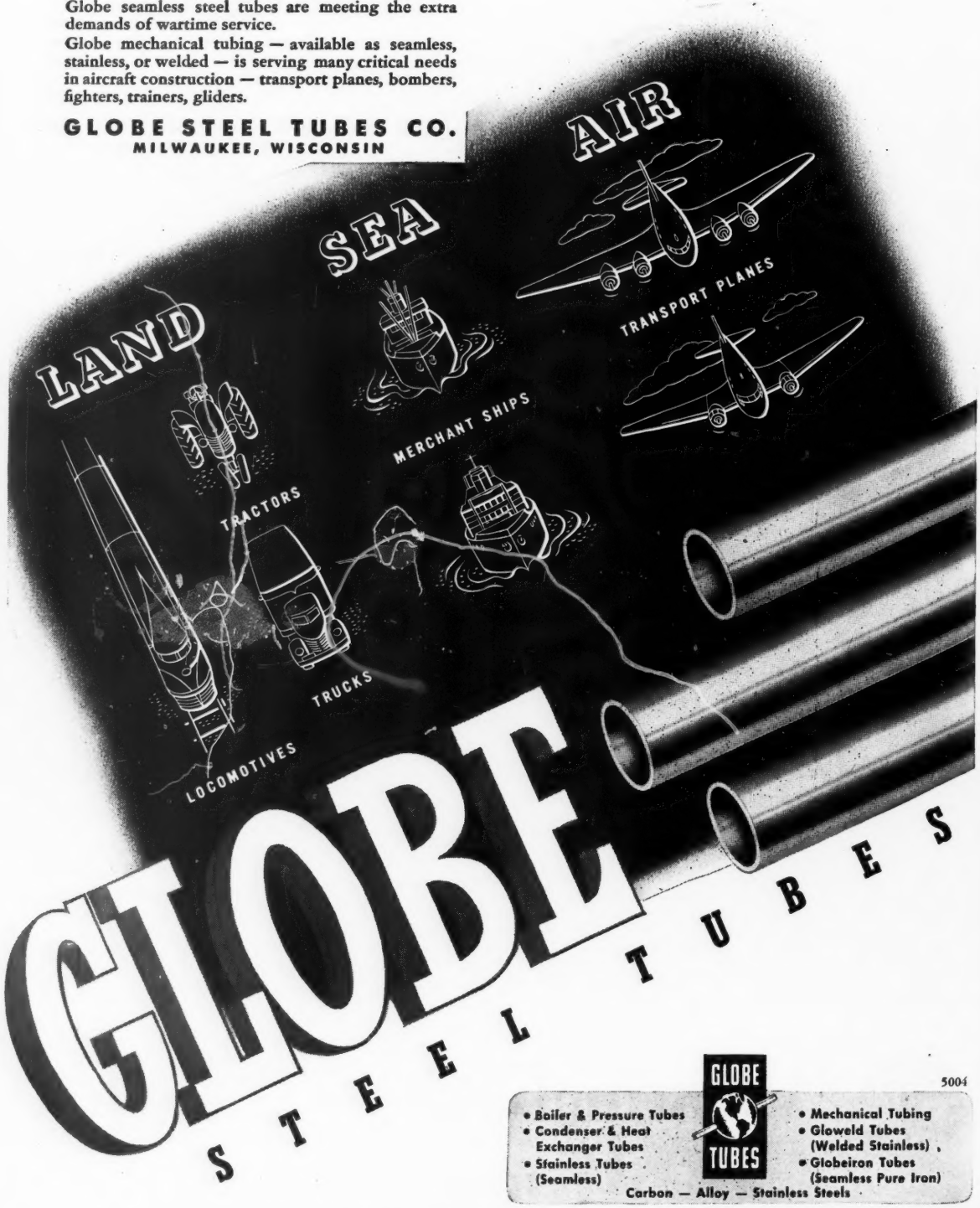
INDISPENSABLE

. . . IN THE CONSTRUCTION OF TRANSPORT EQUIPMENT

In locomotives — in the power plants of war industries — in fighting, transport and merchant ships — Globe seamless steel tubes are meeting the extra demands of wartime service.

Globe mechanical tubing — available as seamless, stainless, or welded — is serving many critical needs in aircraft construction — transport planes, bombers, fighters, trainers, gliders.

GLOBE STEEL TUBES CO.
MILWAUKEE, WISCONSIN



5004

GLOBE TUBES

- Boiler & Pressure Tubes
- Condenser & Heat Exchanger Tubes
- Stainless Tubes (Seamless)
- Mechanical Tubing
- Gloweld Tubes (Welded Stainless)
- Globeiron Tubes (Seamless Pure Iron)

Carbon — Alloy — Stainless Steels

Prevent Valve Failure *before it starts!*

DON'T THROTTLE GATE VALVES
... this wedge and seat face were ruined by wire drawing effect

IT CAN'T HAPPEN TO YOUR GATE VALVES IF...

IF you use Gate valves only for services for which they are designed, you will avoid needless destruction of valves. They are not intended for throttling purposes. The ruined wedge and seat faces pictured here show the result of using a Gate valve partially open to regulate flow. Wire drawing effects are an almost certain result of such misuse, when Gate valves are used in steam, condensate, or other services where foreign matter may be present. For throttling service, use a Plug Seat Globe valve, or a Renewable Disc Seat Globe valve equipped with Jenkins Throttling Nut.

Similar destruction of seating faces is often caused by scale and other foreign matter lodging between the seat ring and wedge faces. And, you can take steps to minimize that possibility. When installing valves and piping, have workers look into them, see that they are clean. After a valve is installed, flush it out periodically . . . close the valve so a small flow under greater pressure is obtained to dislodge any foreign matter that might be in the valve.

Most important is regular inspection of valves. At the first sign of leaks, action should be taken to remove the cause, and repairs should be made before the destruction progresses beyond the repairable stage.

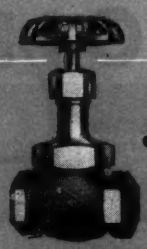
VALVE CONSERVATION PAYS...AND PREVENTS SLOW DOWNS IN WAR PRODUCTION

In peacetime it is wise management to pay close attention to valve conservation. It pays handsome dividends. In today's emergency, valves *must* be kept in efficient operation. Failure of control over vital power and fluids may interrupt the victory-pace of production.

Also, neglect of valves is an inexcusable waste of important metals. New valves can be obtained only for certain uses. Many valves in present use must be kept for the duration.

Inspect valves systematically. Make repairs before serious deterioration begins. Instruct new maintenance men thoroughly. Select new valves with extra care, and have them installed properly. Check up on your program of valve conservation and see that it is adequate. Jenkins Engineers will gladly provide any assistance you need. Send details of present valve problems.

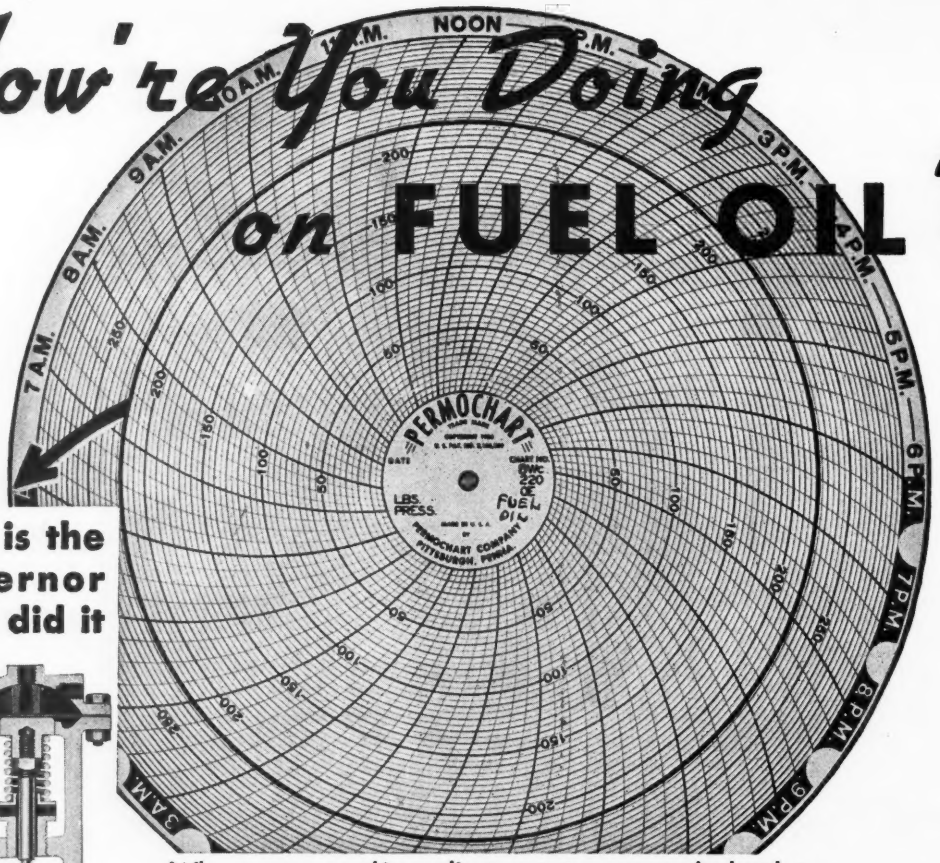
Jenkins Bros., 80 White Street, New York 13, N. Y.; Bridgeport; Atlanta; Boston; Philadelphia; Chicago. Jenkins Bros., Ltd., Montreal; London.



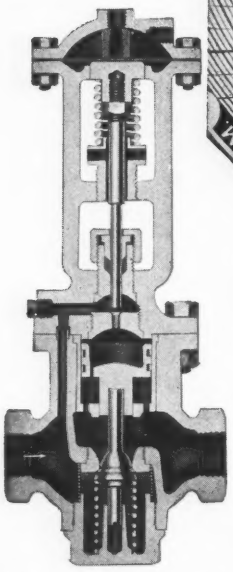
JENKINS VALVES

For every industrial, engineering, marine and power plant service . . . in Bronze, Iron, Cast Steel and Corrosion-Resisting Alloys . . . 125 to 600 lbs. pressure.

How're You Doing on FUEL OIL?



This is the governor that did it



Foster Type 38-P6 Diaphragm type, Auxiliary operated Pump Governor for constant pressure service. This type of governor operates on initial pressures up to 600 lbs. at 750°F, for discharge pressure up to 800 lbs. Full details on this and other governors in Catalog 70.

When you are making adjustments to squeeze the last b.t.u. out of your fuel oil allotment, you need constant fuel oil pressure to start with. And fuel oil pressure is one variable you can easily eliminate.

The chart shows a 24-hour cross section of the close regulation you can expect from a Foster Type 38-P6 Pump Governor, day in, day out—year after year.

This particular governor has been giving satisfactory, trouble-free regulation for 9 years because it is the right size and type for the job, and it was properly installed.

There is a Foster Automatic Valve for *every* service requirement. When you are faced with a pressure problem or temperature problem of any kind, why not select the proper size and type from a *complete* line where you are not limited in your choice? Our engineers will be glad to help you find the right answer to your problem.

Illustrated catalog on the complete Foster line, with many pages of useful engineering data will be sent if the request is made on company letterhead. Simply ask for Catalog 70.

FOSTER ENGINEERING Company

PRESSURE REGULATORS...RELIEF AND BACK PRESSURE VALVES...AUTOMATIC STOP AND CHECK VALVES...ALTITUDE VALVES...DAMPER REGULATORS...FAN ENGINE REGULATORS...PUMP GOVERNORS...TEMPERATURE REGULATORS...LIQUID LEVEL CONTROLLERS...FLOAT AND LEVER BALANCED VALVES...NON-RETURN AND TRIPLE DUTY VALVES...VACUUM REGULATORS OR BREAKERS...SIGHT FLOW BOXES...STRAINERS...SAFETY VALVES...SIRENS

111 MONROE STREET • NEWARK 1, N. J.

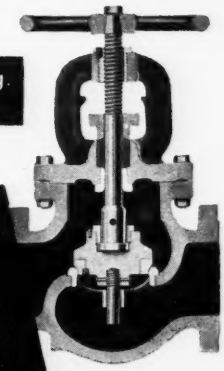
12-FE-3

GIVE THE VALVE A CHANCE ...SELECT IT FOR THE JOB

Today, when it is more important than ever before to keep pipe lines flowing at maximum efficiency, too much care cannot be given to selecting the right valve for each job. Before you "draft" a valve for that all-important line, make sure it is the one you really need.

Here is the answer to a frequently-asked question on valve selection, taken from the files of The Kennedy Valve Manufacturing Co. Other problems will be considered in succeeding advertisements in this series.

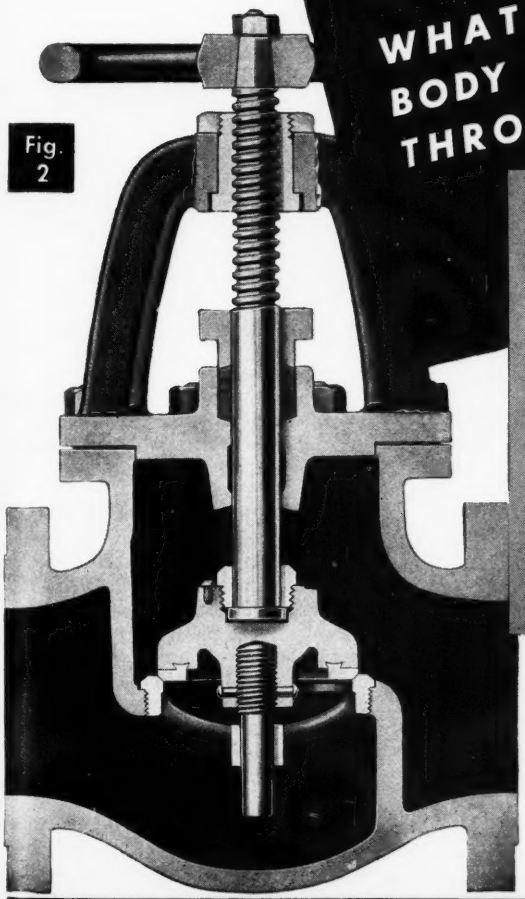
Fig. 1



Question:

WHAT TYPE OF IRON-BODY VALVE IS BEST FOR THROTTLING SERVICE?

Fig. 2



Answer:

Globe valves with renewable bronze-faced discs (see Fig. 2) are recommended for throttling service because, when gate valves are used, the high velocity of flow tends to erode their seating surfaces. For higher pressures, the globe valve disc should have a throttling lip or leader (as shown in Fig. 1) which makes the seat self-cleaning and minimizes wire-drawing.

FOR THROTTLING SERVICE SPECIFY IRON-BODY GLOBE VALVES WITH BRONZE-FACED DISCS.

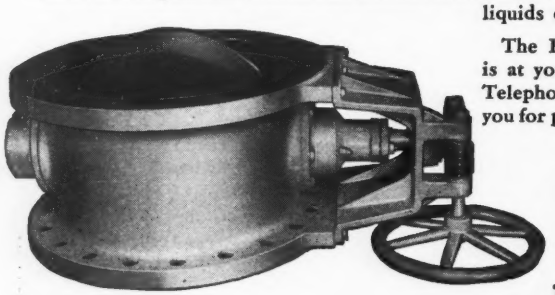
If you have a valve selection problem, write to us. As Kennedy makes a complete line of standard gate, globe, angle and check valves, you can be sure of receiving unbiased help. For full description of Kennedy valves, pipe fittings and fire hydrants, send for 240-page Kennedy Catalog.

KENNEDY VALVES • PIPE FITTINGS • FIRE HYDRANTS
THE KENNEDY VALVE MFG. CO. • ELMIRA, N.Y.

R-S Valve Engineering Service is NATION-WIDE

In strategically located cities from Boston to Dallas, and from New York to San Francisco, there are thoroughly experienced R-S Valve engineers who are eager to assist in the simplification of valve installations, willing to recommend the type of equipment best adapted to a particular control or shut-off condition and cooperative in pointing out possible changes in present equipment that will effect greater efficiency and economy.

Carefully selected for their engineering ability and experience in the installation and operation of valves, these men have been especially trained in the selection of alternate metals for resistance against heat, abrasion and corrosion as well as the application of R-S Valves under high or low pressures and temperatures whether the medium to be controlled is air, gas, steam, liquids or semi-solids.



The R-S representative is at your beck and call. Telephone the one nearest you for prompt service.

No. 502

20-inch, 125 pound American Standard Valve, hand wheel control, ball bearing mounted with stuffing box.

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15 to 900 psi

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VALVE DIVISION

R-S PRODUCTS CORPORATION

4535 Germantown Ave. • Philadelphia 44, Pa.

R-S Streamlined BUTTERFLY VALVES

Industrial Electronics Today and Tomorrow

(*Continued from Page* 87)

ments of time in a series of repeated sequences has been tackled and solved in many mechanical ways, but usually by resorting to some form of motor-driven gear train and cam. Without a single moving element, except the electromagnetic relay itself, electronic timers afford an accurate, simple, and readily adjustable solution to the process timing problem. The life of the equipment is measured in terms of tens of millions of operations, whereas two million operations without repair or adjustment would be an exceedingly long life for a mechanical timer."

Electronic Lighting Control

One of the milestones in the use of electronic control was the application of thyratron control in 1929 at the Chicago Civic Opera Company. This equipment provided control for 160 lighting circuits, any of which might handle several kilowatts of lighting load. A more recent application of large-scale electronic control is in operation at Radio City Music Hall. Control for 313 lighting circuits and five preset scenes in addition to the control of the scene undergoing presentation is provided. Nerve center for the 1500 electron tubes handling this job is a centrally located operator's control board.

"Perhaps the best known electronic control is the photoelectric control, whose manifold applications to countless industrial operations exceed those of all other industrial electronic devices in quantity and variety," said Mr. Alexander. "To control a device or process without touching it, such as guiding a web of fragile tissue, counting a freshly painted object or a sterile article, or checking or regulating the temperature of a white-hot heat process, renders the phototube and its associated equipment a real industrial tool."

The phototube is playing a most important part in high-speed processes, such as policing the printing of paper moving at 1000 fpm, to assure that all colors are in register; detecting pinholes in steel strip moving as fast as 1000 fpm; holding tension on loops of continuous web or strip of material being processed in different machines at high speeds; holding steel strip in register as it is being coiled so that the coils will be uniform; and many similar applications.

WeldELLS have everything ★

"They're built to give the man on the job a hand"

FROM the way they pile the work on me these days you'd think my job as foreman of the pipe crew is to put in the piping today that the front office won't finish planning till tomorrow!

The front office crowd might consider that laying it on a little thick. But whatever they think, they will have to admit that we have kept up with their wildest demands and done the job right, too.

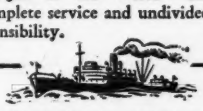
Of course the main credit for that goes to fellows who do the work. But down to the last man they would be the first to agree that they couldn't have covered as much ground, or covered it as well, if it hadn't been for their old friend, WeldELLS.

WeldELLS and other Taylor Forge Welding Fittings are built to step in and give a hand. You don't have to grope for the proper size because size and weight are marked right there on the fitting. Tangents make them easy to line up. Accurate lathe bevels and lands make welding fast and sound. Precision quarter-marks guide the work.

If you want a fast job — a sound job — an economical job — take a tip from me and use the welding fittings that have *everything!*

★ **WeldELLS alone have all these features:**

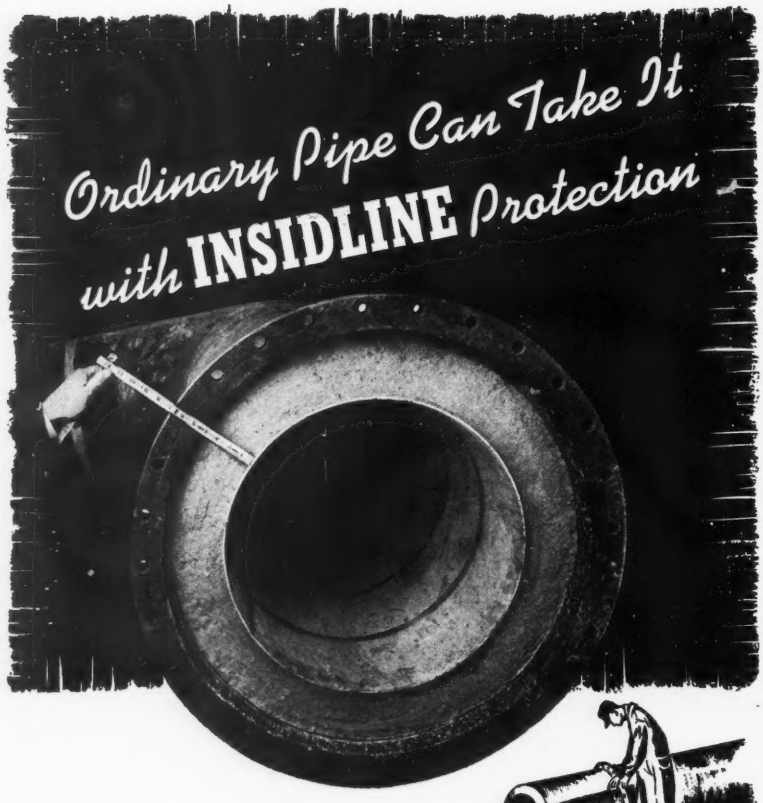
- **Seamless** — greater strength and uniformity.
- **Tangents**—keep weld away from zone of highest stress—simplify lining up.
- **Precision quarter-marked ends** —simplify layout and help insure accuracy.
- **Selective reinforcement** — provides uniform strength.
- **Permanent and complete identification marking**—saves time and eliminates errors in shop and field.
- **Wall thickness never less than specification minimum**—assures full strength and long life.
- **Machine tool beveled ends**—provides best welding surface and accurate bevel and land.
- **The most complete line of Welding Fittings and Forged Steel Flanges in the World** — insures complete service and undivided responsibility.

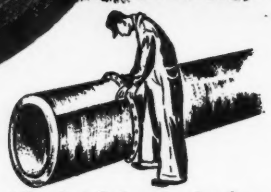


The list of Taylor Forge's contributions to the war effort only begins with WeldELLS. One of many examples is Taylor Corrugated Marine Furnaces, essential to many merchant ships and transports.

* WeldELLS and many other Taylor Forge products are produced in Byers Genuine Wrought Iron.

TAYLOR FORGE & PIPE WORKS, General Offices & Works: Chicago, P. O. Box 485
NEW YORK OFFICE: 50 CHURCH ST. • PHILADELPHIA OFFICE: BROAD ST. STATION BUILDING





Insidline installations in pipe from 2" I. D. to 36" I. D. are made with a cartridge type of insulation that is built up first and then drawn into the pipe.

Insidline is a carefully built-up insulation for the inside of pipe. It eliminates the necessity of expensive, hard to get, high-alloy, steel piping for new industrial processes requiring high-temperature gases and vapors under pressure. With this inside insulation, ordinary carbon steel pipe can be made to handle gases up to 1800°F., at high pressures and velocities.

By keeping the pipe temperature at 750°F., or below, "creep" is prevented and the usual stress allowances permit indefinite operation. The number of expansion joints, bends, and other provisions for pipe expansion are greatly reduced, with resultant simplification of design and construction economies. Our engineering staff will gladly consult with you on the application of Insidline to your particular piping problem.

In larger diameters from 36" up to over 100" a panel type of Insidline is built up on the inside of the pipe.

Send for descriptive booklet.

BALDWIN-HILL CO.

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NEW YORK, N. Y. • CHICAGO, ILL. • KALAMAZOO, MICH. • HUNTINGTON, IND.

Water Conference

(*Continued from Page* 83)

to work out. One of those developments that has been going on since the early days of water treatment is that of speeding up chemical reactions and clearing the treated water of precipitates. R. C. Embshoff of Infilco Inc. reviewed the principles of equipment designed by his company for this type of service, pointing to the influence the application of recent principles have had on the effectiveness of this equipment.

Attention was called to a new method of lime-soda softening which is now available. The method was described by Harry L. Beohner of the Permutit Co. who stated that it depends on a catalytic or seeding action of granular particles in a treating tank of conical shape. The treatment employed converts the soluble calcium and magnesium salts to the insoluble precipitates of calcium, $CaCO_3$, and magnesium, $Mg(OH)_2$. The device, known as the Spiractor, then rapidly separates the treated water from the precipitates formed, and provides means for disposing of the waste product which accumulates.

High Pressure Boiler Scale

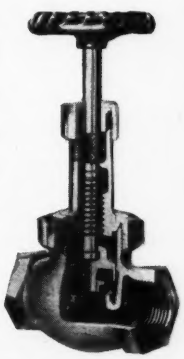
That the operation of steam boilers at high pressures has presented previously unforeseen boiler water troubles is a fact well known to engineers in the field. Laboratory experiments, however, have been needed to determine the exact chemical changes that take place and this study has been undertaken by J. A. Holms of National Aluminate Corp. At this Conference he showed the effect of increasing pressure from 100 to 800 psi and at three different ratings of a specially designed laboratory boiler. Various combinations of calcium, magnesium, phosphate, silica, alumina, and a few organic materials were used. This was accomplished by making up synthetic water and adding one constituent at a time. The object of the test runs was to determine just which of the substances found in water are most scale-forming and under what combinations they might cause the most trouble.

Among recent studies in the water treating field is a research program carried out in the Cochrane Laboratories and reported to the Conference by Frank Kemmer and Joseph Thompson dealing with the characteristics of acid regenerators and carbonaceous zeolites. Their investigations have led to the

Fairbanks Valves

are on the job in hundreds of war plants and ships, doing their part to hasten production by preventing interruptions.

We are grateful that careful attention to every detail of design and construction has made Fairbanks Valves dependable for long, continuous service.



Write for a copy of Catalog No. 42.

THE FAIRBANKS COMPANY
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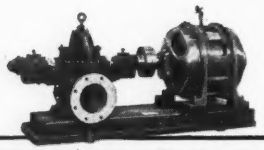
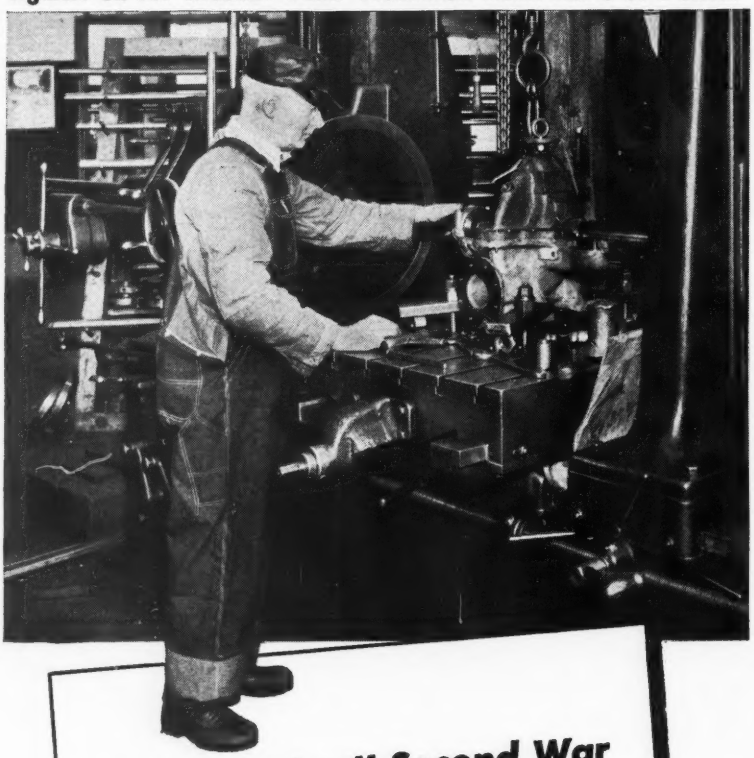


Fighters on the WARREN PUMP Production Front. No. 8 of a Series



This is "Jakes" Second War on the Warren Production Front . . . AND HE ISN'T DOING HITLER ANY GOOD

"JAKE" Noppa, a veteran of 26 years experience with Warren, is a freedom-loving man . . . and he fights for it in a way that does the dictators the most harm — helping to make the Warren Pumps needed on the war and war production fronts. How effectively "Jake" and his fellow Warren workers are doing their jobs is symbolized by the "E" for excellence pins that the Army and Navy of the United States has awarded to them! And every man and woman on the Warren Production Front can be depended upon to produce the efficient, reliable Warren Pumps that are needed in increasingly larger quantities . . . depended upon for an honest endeavor to break every production record asked of them for the pumps that are "built to fit the job."

WARREN PUMPS

WARREN STEAM PUMP COMPANY, INC.
WARREN, MASSACHUSETTS

conclusion that the use of acid regenerated zeolites in conditioning water is predicated on an understanding of reactions between the zeolites and minerals dissolved in the raw water. Exchange capacity and acidity of the treated water are found to be affected by the ratio of the sodium ion to the total cations and the ratios of the bicarbonate to total anions.

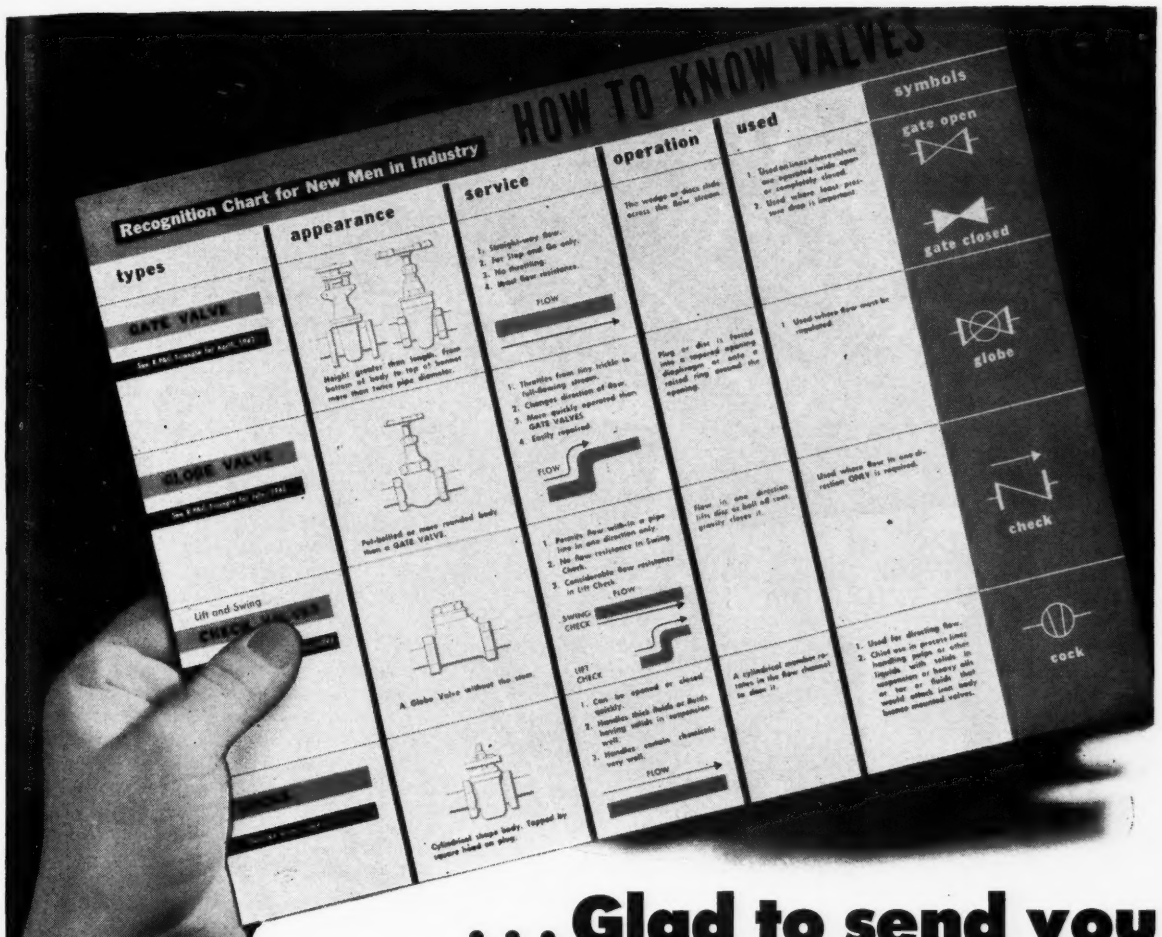
Recent years have witnessed rapid progress in the two-step ion exchange process of dimineralizing water, the latest developments in which are described by Durando Miller of the Permutit Co. It was reported that economy of operation and high quality of effluent produced have been two factors affecting the growth of plants of this type. Current developments of interest include huge wood gravity dimineralizing plants, use of automatic control of regeneration, and application of vacuum deaerators instead of the customary degasifiers, where oxygen-free water is desired.

Saved—850,000 Pounds of Tin

MORE THAN 850,000 lb of tin have been saved by the General Electric Company in the 23 mo since Pearl Harbor as a result of changes adopted by the company in its solders and babbitt alloys. Calculated in terms of No. 2 food cans, tin-plated both sides in accordance with today's WPB regulations, this saving corresponds to the amount of tin on about 825,000,000 such cans—cans enough to fill many a pantry.

War had hardly been declared before General Electric engineers began to investigate the possibilities of solders containing less tin. Solders before the war were high in tin content, most formulas calling for about half tin and half lead. Pure tin was employed for many jobs. During 1942 the WPB limited solders to a maximum of 30 per cent tin except for certain applications, and this year limits tin content to 20 per cent in solders for general work.

This further restriction on tin content did not greatly affect G-E practice because at the beginning of the tin-conservation program a year earlier it was anticipated that eventually it would be necessary further to restrict tin, so a 20 per cent tin solder was introduced for general-purpose applications at that time.



. . . Glad to send you this useful chart

This 12″ x 9½″ chart originally was prepared to give new men in industry a quick way to classify valves • Classify valves by type; identify them by outward appearance; appreciate the services for which each type is suited; explain the broad principles on which valves operate, classify valves as to use and show the symbols by which each type is indicated on piping layouts • Experienced men, seeing these charts, also have asked for one for their own use. So we have printed a quantity in two colors on heavy cardboard—convenient for wall tack-up or filing.

Glad to send you a copy. Address our offices in Reading, Pennsylvania.

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Yes, Henszey Flow Indicators give you the rate of flow—instantly and accurately at any time. They register the flow from zero to 100% and they tend to indicate a pulsating flow exactly as it occurs. The graduations on the dial are uniformly spaced from one end to another and read direct—without constants. There are only three moving parts—breakdowns due to complicated mechanisms and gears are eliminated. They can be installed right in the pipe line without additional supports.

So, if you need to know the flow instantly and accurately—consider Henszey Flow Indicators. Installations are satisfactorily performing in nationally known paper mills, chemical plants, petroleum refineries, milk condenseries and many other war industries.

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Continuous Blowdown • Distillation Systems • Heat Exchangers
Feed Water Meters • Boiler Feed Regulators • Proportioning Valves

Today's Solders

General Electric today is using a series of solders, depending on the application.

For general-purpose work a solder containing 20 per cent tin, 1.25 per cent silver, 1.5 per cent antimony, and the balance lead may be employed. It can be used with noncorrosive fluxes such as rosin on anilene phosphate, on bare, pretinned, or cadmium-plated surfaces; a corrosive flux, such as the zinc chloride types, is used for bare steel and zinc-plated copper or steel. Rupture strength at elevated temperatures is better than that of 40-50 per cent tin-lead solder. This 20 per cent tin solder is the most popular solder in use today. It is being used in wire form, both solid and rosin-cored, for all types of electrical connections which formerly were made with solders ranging from 40 per cent tin, 60 per cent lead to 60 per cent tin, 40 per cent lead. About the only change in technique required to use the lower tin solder is to use a hotter soldering iron since the 40 per cent tin solder melts at 455 F and the 20 per cent tin solder at 518 F. This new solder is also used in larger solder pots in place of 40 per cent tin solder for soldering armatures.

A silver solder, containing 2.5 per cent silver and the balance lead, and melting at 579 F, is used chiefly for applications requiring high rupture strength at elevated temperature. This solder does not flow and wet as readily as pure tin. It calls for a corrosive flux on bare surfaces, but rosin flux can be used on pretinned surfaces. It is used chiefly for soldering rotor binding bands.

Two compositions are being used for retinning or dip-soldering in solder pots, but neither is recommended for soldering-iron work. One consists of 10 per cent tin and 90 per cent lead, and melts at 567 F; the other has 10 per cent tin, 1.5 per cent silver, and 88.5 per cent lead. The second has somewhat better spreading creep qualities. Zinc chloride (corrosive) type flux is used, with subsequent washing to remove flux residue.

A solder containing 30 per cent tin, 2 per cent antimony, 1.25 per cent silver, and 66.75 per cent lead is used for soldering wiped joints. While it handles well, it is more susceptible to porosity than a 40 per cent tin, 60 per cent lead wiping solder.

General Electric has not found it possible to change to low tin

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THE FIRING LINE

THE FIRING AISLE

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IN TIME OF WAR

Spearheading the tremendous production of guns, planes, tanks, and ships for our fighting forces, are the boiler room firing aisles of industry! Here, steam generating units are called on to meet extraordinary operating requirements day after day with minimum maintenance.

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Vogt builds steam generating equipment in many types and sizes to meet every power, heating or processing requirement. Bulletins are available upon request.

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Let Your Used Darts See ACTIVE SERVICE on the "Front Lines"

Dart Unions are built of the stuff that lets them become "old campaigners" . . . capable of giving tight joint performance again and again, even though they have already been used many times before.

This reliability that Darts give throughout a long life is due to these important things. First, Darts have matched bronze seats ground to trueball surfaces. Second, Dart Bodies and Nuts are made of highest air refined malleable iron that resists pipe strains and rough handling.

It pays to keep searching your plant for used Darts to put back "in uniform." And see your supplier today if you need *new* ones.

DART UNIONS

E. M. DART MFG. CO., PROVIDENCE, R. I.

solders for every application. Soldering commutator-winding joints still requires 100 per cent tin solder. Such joints are subjected to moderately high temperatures for a soldered joint and are under high stress, demanding a solder with high temperature rupture properties. The necessity for use of a non-corrosive flux also limits the choice of solders to those which wet and flow readily with a rosin flux.

New Babbitt Alloys

Babbitt alloy, used in lining bearings, previously contained 83⅓ per cent tin, and 8⅓ per cent each of copper and antimony. Today's tin conservation order of the WPB restricts tin content in babbitt to 12 per cent, except for implements of war, in which case high tin content babbitts are still permitted unless a lower tin content is practicable. The alloy used by G. E. today contains only 1 per cent tin. The remainder consists of 15 per cent antimony, 1 per cent arsenic, 0.5 per cent copper, and 82.5 per cent lead. This composition is available from many metal producers.

NEW EQUIPMENT

Information that you desire about any equipment will be gladly furnished without obligation. WRITE TO POWER PLANT ENGINEERING

Single Handed Fire Extinguisher

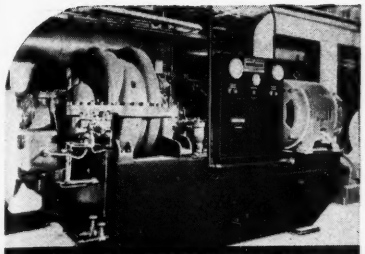
SPEED and maneuverability are all-important in combating the sudden "spot" fires that constantly menace machine shops, production lines, power houses. Keeping these factors in mind, Randolph Laboratories, Inc., Chicago, Ill., has produced a Carbon Dioxide fire extinguisher that requires only one hand in operation—from the moment the unit is grasped until the fire is completely out.

The Randolph "4," latest in Randolph's 4 lb CO_2 series, features a self-aimed, fixed discharge horn, and a thumb-operated trigger valve that releases a penetrating blanket of Carbon Dioxide—a gas that smothers fires in an instant. This new designing, exclusive with Randolph Laboratories, makes Randolph "4" one of the fastest-firing extinguishers manufactured.

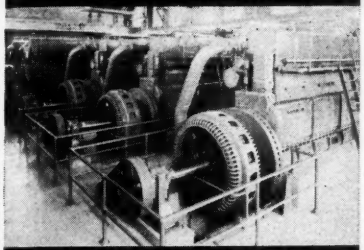
The operator, as though aiming a revolver, grasps the extinguisher's arched-steel handle, while the thumb presses the trigger directly above. The fire-resistant horn, permanently regulated to fixed firing position, eliminates the necessity of making aiming adjustments. One hand is free for precautionary measures, and the chances of "operator's panic" are greatly reduced.

WORTHINGTON

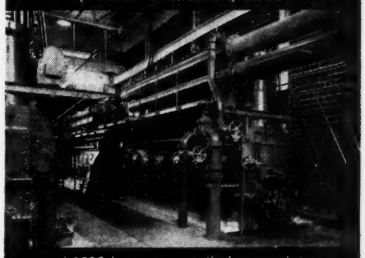
EQUIPMENT FOR POWER GENERATION



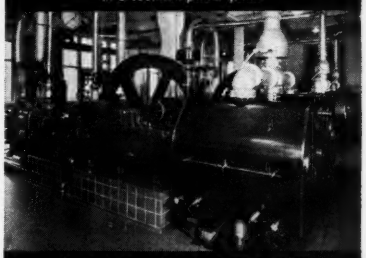
Centrifugal refrigerating compressor, water cooler, water-cooled condenser combined



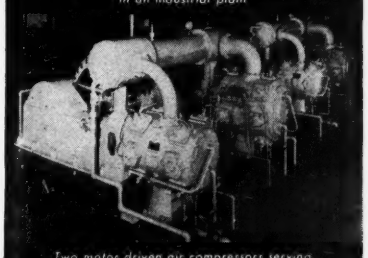
Five diesel engines generating electric power for a western cooperative



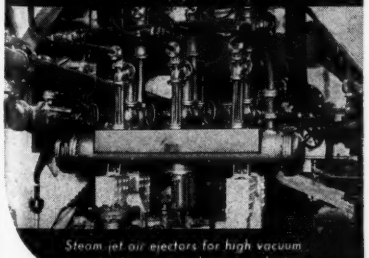
A 1500-horsepower vertical gas engine in a southern power plant



Steam driven refrigerating compressors in an industrial plant



Two motor driven air compressors serving a western airplane motor plant



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All types 25 hp. to 10,000 hp.

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Up to 2500 hp.

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Of all capacities, With all auxiliaries.

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For moderate to high vacuum service.

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For medium and high-pressure service.

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For every required application.

AIR AND GAS COMPRESSORS
For small, medium and large air supply. Steam, motor or engine driven.

FEEDWATER HEATERS AND DE-AERATORS
Open type, for individual requirements.

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Softeners and filters.

REFRIGERATING AND AIR CONDITIONING EQUIPMENT

TURBINE WELL PUMPS
For general, sump and other services.

STEAM, POWER AND ROTARY PUMPS
For boiler feed and varied services.

LIQUID METERS
All types; hot or cold water, chemicals, etc.

V-BELT DRIVES
Complete drives, sheaves or belts only.

PORTABLE COMPRESSORS AND AIR TOOLS
For new construction and maintenance service.

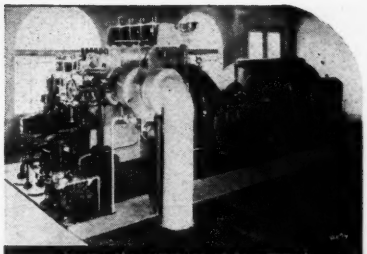
A complete coverage for every important power plant function

WORTHINGTON PUMP AND MACHINERY CORPORATION

General Offices: **HARRISON, NEW JERSEY**

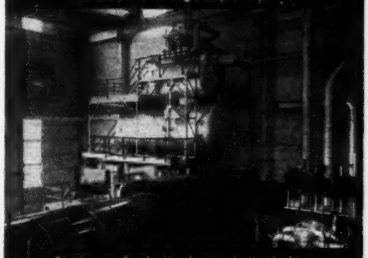
Offices and Representatives in Principal Cities

IC3-28

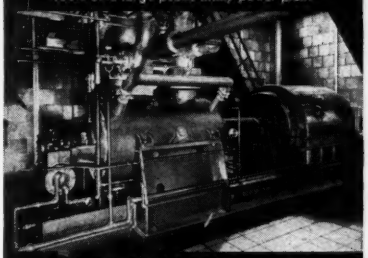


Steam turbo-generator unit in municipal power and light service

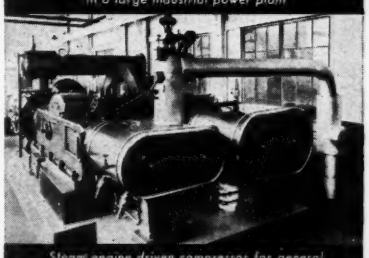
A 73,000 square foot surface condenser installed in a large airplane plant



Stationary feedwater heater in the turbine room of a large public utility power plant



High-pressure centrifugal boiler feed pump in a large industrial power plant



Steam engine driven compressor for general air supply in a large process plant

Two angle type compressors for small and medium air supply

Copper Brew Kettle covered with 2½" coating of B-H No. 1 Cement and finished with B-H Weatherseal.

SOMETIMES IT PAYS TO LAY IT ON THICK!

Use B-H WEATHERSEAL to Protect Exposed Insulation

Cover all insulation exposed to infiltration of water or moisture with B-H Weatherseal. This Baldwin-Hill product is an emulsified, asphalt compound furnished ready-mixed in plastic form. By reason of its exceptionally high coverage and low percentage of shrinkage, the per square foot cost is low. One hundred pounds will cover 55 square feet of surface ¼ inch thick. After drying, dehydration reduces the thickness to ⅛ inch, giving a smooth, complete seal over the entire area. You simply trowel it on. Stays permanently black—no fading or spotting. Send for generous sample of B-H Weatherseal and see for yourself how easily and thoroughly it works.

BH BALDWIN-HILL CO.

577 KLAGG AVE. • TRENTON 2, N. J.

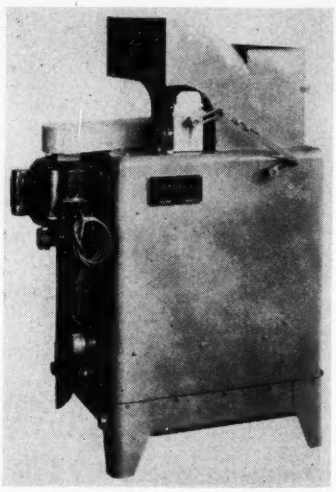
NEW YORK, N. Y. • CHICAGO, ILL. • HUNTINGTON, IND. • KALAMAZOO, MICH.

Many industrial plants, engaged in fire-hazardous production, have employed the Carbon Dioxide 4 lb extinguishers in a dual protection system. Some units are permanently bracketed at specified intervals, to guard fixed machinery, while many others are held in reserve to be shifted in covering periodic fire-hazardous work such as gasoline drainage, overhead welding, or spark-throwing grinding jobs.

Additional information on Carbon Dioxide fire-fighting methods may be obtained from the manufacturer (8 E. Kinzie St., Chicago, Ill.) on written request.

Compressed Air After Cooler

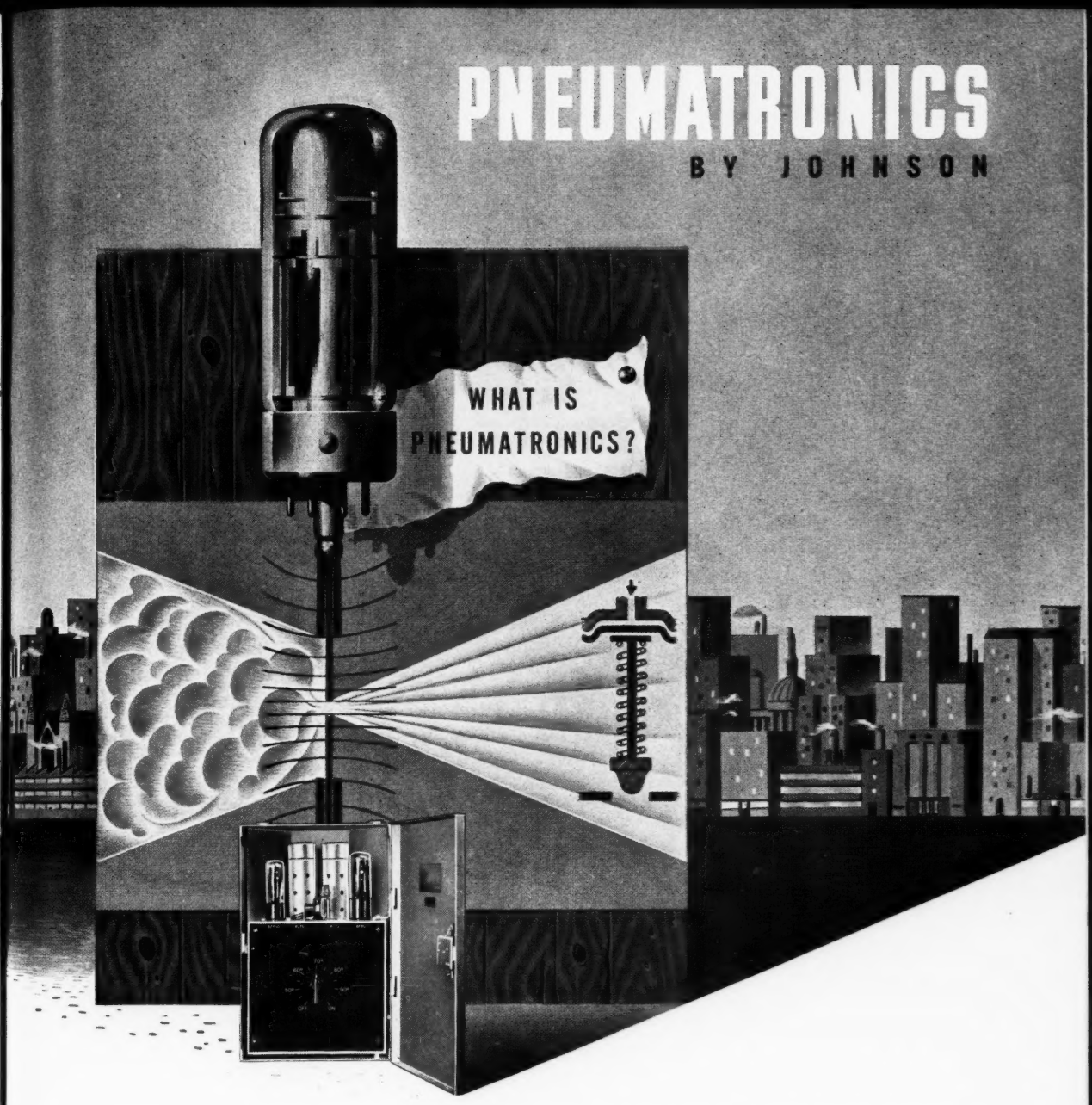
THE NEW Niagara Aero after cooler for compressed air, manufactured by the Niagara Blower Co., 6 E. 45th St., New York-17, N. Y., uses the evaporative cooling principle to obtain the lower temperature and a new design gives greatly increased capacity in compact apparatus. Air, drawn by a fan through a water spray across coils containing the compressed air is



the cooling medium and temperatures within 10 F of the wet bulb air temperatures can be maintained. This permits lower temperatures by 10 to 25 F, than conventional coolers and produces compressed air that contains only one-half to three-fourths the amount of water formerly experienced with the best practice. The equipment is also applied to gases generated for industrial use.

PNEUMATRONICS

BY JOHNSON



Pneu-ma-tron'-ics is a combination of the best in electronic circuits, coupled with pneumatic temperature control equipment developed by the Johnson Service Company.

Johnson Pneumatronic temperature control equipment has been in actual use in the field over three years and, for the duration, is available for a limited number of additional applications.

Most temperature control problems will continue to be solved best by standard Johnson pneumatic control systems. Pneumatronic principles, however, may be applied profitably to certain types of automatic temperature control problems in industries and in the control of steam and hot water heating systems.

PNEUMATRONICS JOHNSON SERVICE COMPANY, MILWAUKEE 2, WIS.
DIRECT BRANCHES IN ALL PRINCIPAL CITIES

"THIS YEAR, LET'S PAY THE BONUS IN WAR BONDS

. . . and drive even harder on the pay-roll savings plan!"

Make War Bonds the Christmas Order of the Day. Urge your workers to make their personal Christmas gifts in the form of War Bonds—and practice what you preach! Make this a 100% War Bond Christmas—to insure future Yuletides of peace and prosperity.

Make up your own posters to spread the "War Bonds for Christmas" story across your plant. Tell the story again and again on bulletin boards, in your plant magazine, and on pay envelope stuffers.

But don't forget your basic, all-important Pay-Roll Savings Plan. How's it going, these days? Perhaps it needs a bit of stoking-up right this very minute, to hold its full head of steam against the competitive demands of the holiday season.

Well, you're the man to stoke it! You can't expect it to keep running indefinitely on last summer's enthusiasm. See to it that your participation percentages, and your deduction percentages, *both* end up the year at new levels.

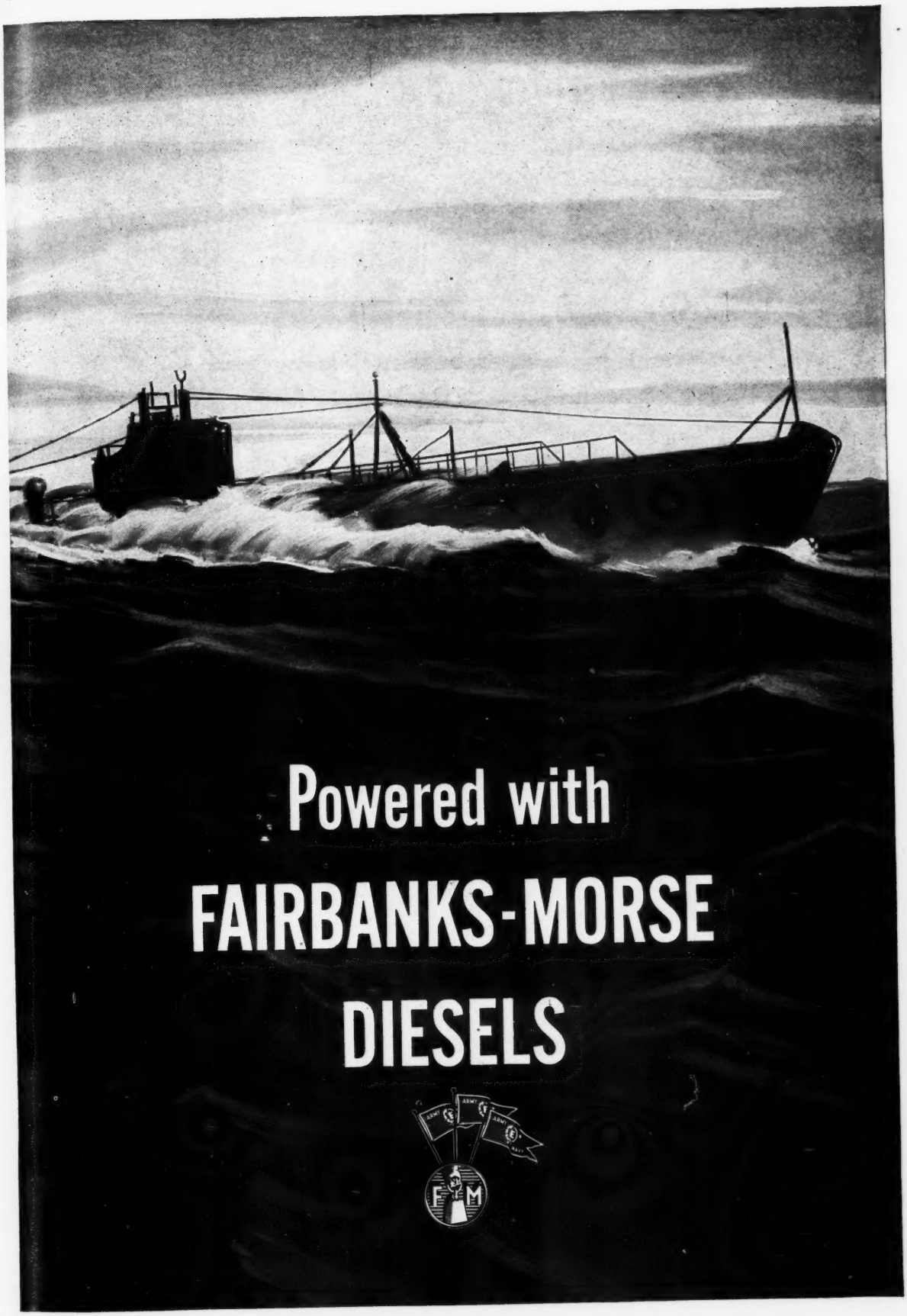
Every month, now your Pay-Roll Savings ought to run well ahead of the preceding month. *For so many families that formerly depended on the earnings of a single worker, now enjoy the combined earnings of several.* Such *family* incomes are doubled, trebled, even multiplied many times.

Now's the time to turn as much as possible of these increased earnings into War Bonds—War Bonds for Christmas . . . and War Bonds the whole year 'round!

GIVE THE PRESENT WITH A FUTURE—WAR BONDS!

This space contributed to Victory by **POWER PLANT ENGINEERING**

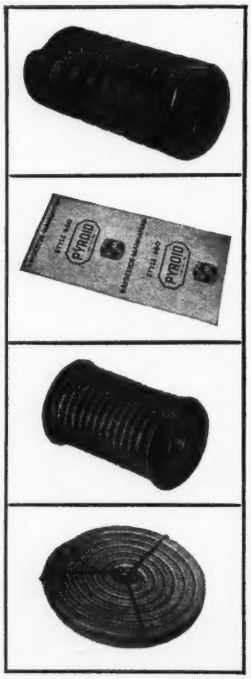
This advertisement prepared under the auspices of the United States Treasury Department and the War Advertising Council


Powered with
FAIRBANKS-MORSE
DIESELS

R/M PACKINGS DELIVER THE GOODS

Year after year, R/M Packings have made a present to industry. This present has been an extra margin of safety, over and above what it takes to hold normal pressures in check. Now that steam, air, fuel, and oil lines must operate under higher pressures than ever to meet war-time demands, R/M Packings are still more than able to stand the strain.

There are R/M Packings engineered to meet every type of packing problem. Your local jobber will furnish you with catalog and complete information, or write us direct.



ARMY E NAVY

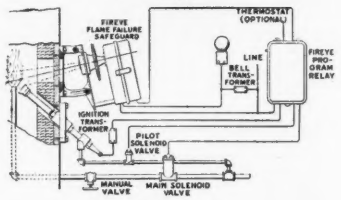
Awarded to R/M
North Charleston Plant

INDUSTRIAL SALES DIVISION
RAYBESTOS-MANHATTAN, INC.
MANHEIM, PA.
BRIDGEPORT, CONN. NORTH CHARLESTON, S. C. PASSAIC, N. J.
Makers of Packings for Every Industrial Use

Flame Failure Protection

FIREYE Type F28C, a photoelectric system for providing instantaneous fuel cut-off in any pressure-fed burner in the event of flame failure, is announced by Combustion Control Corp., Cambridge, Mass. Capable of monitoring flame of any intensity, the system is applicable to oil, gas, or pulverized coal burners and is the first to operate entirely from direct observation of the flame itself rather than wholly or partly from such secondary flame characteristics as temperature or electrical conductivity. Because Fireye is actuated not by the effect of flame failure, but by the actual presence or absence of flame, it operates immediately and therefore completely eliminates the explosion hazard present when even a few seconds elapse before fuel cut-off.

FIREYE Type F28C



Typical FIREYE
Installation For Automatically Ignited Oil Burner

The device is used with manually ignited burners to cut off fuel and sound an alarm; or, when the burner is automatically fired, with Program Relay Type R25, to program fuel pump and valve operation, intermittent ignition system, purging period, and recycling.

It is designed to operate at relatively high ambient temperatures, and is mounted directly on the furnace wall and watches the flame through a window in the wall of the fire chamber. Once the lens of the optical system has been aligned, the field of vision of the electric eye is limited to the flame itself and extraneous light is rejected.

Sperry Hydraulic Control

SPERRY PRODUCTS, INC., Hoboken, N. J., have developed an interesting hydraulic system of control that should have many applications in different fields. It is a positive system based on the fluid displacement principle.

The control consists of two elements: the transmitter, fitted with a handle, and the receiver which delivers through its lever whatever motion is imparted to the transmitter handle. Transmission is deadbeat, free of lost motion or resilience.

THOROUGH CLEANING

... another advantage of

MIDWEST

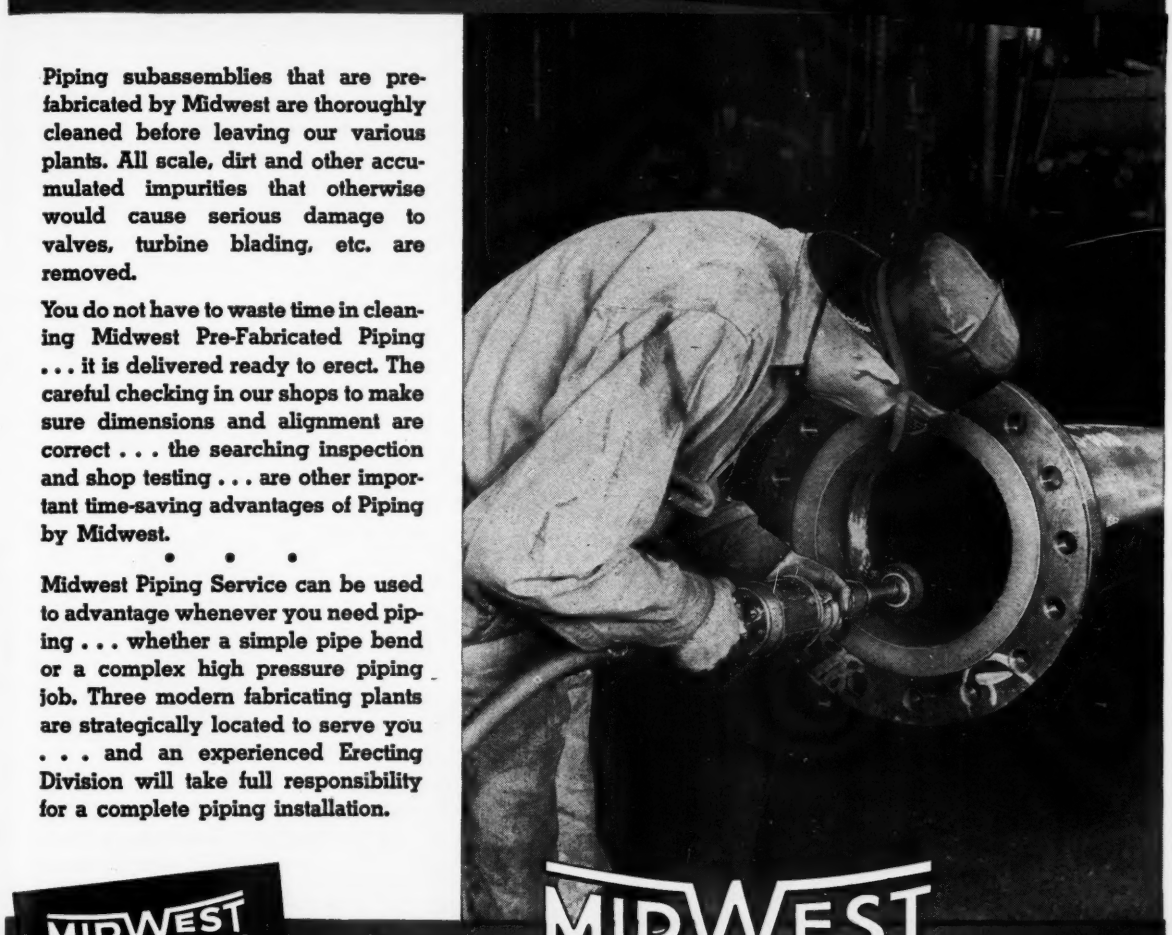
PRE-FABRICATED PIPING

Piping subassemblies that are prefabricated by Midwest are thoroughly cleaned before leaving our various plants. All scale, dirt and other accumulated impurities that otherwise would cause serious damage to valves, turbine blading, etc. are removed.

You do not have to waste time in cleaning Midwest Pre-Fabricated Piping . . . it is delivered ready to erect. The careful checking in our shops to make sure dimensions and alignment are correct . . . the searching inspection and shop testing . . . are other important time-saving advantages of Piping by Midwest.

• • •

Midwest Piping Service can be used to advantage whenever you need piping . . . whether a simple pipe bend or a complex high pressure piping job. Three modern fabricating plants are strategically located to serve you . . . and an experienced Erecting Division will take full responsibility for a complete piping installation.



MIDWEST PIPING SERVICE IS NATION-WIDE

ST. LOUIS

PASSAIC

ANGELES

MIDWEST

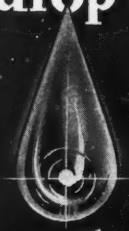
PIPING & SUPPLY COMPANY, INC.

Main Office: 1450 South Second St., St. Louis 4, Mo.

Plants: St. Louis, Passaic (N. J.) and Los Angeles

Sales Offices: Chicago—645 Marquette Bldg. • Houston—229 Shell Bldg. • Los Angeles—530 Anderson St. • New York—(Eastern Division) 30 Church St. • Tulsa—533 Mayo Bldg.

Just a drop of water-



harmless···

or is it?

Although specially treated for use in your water consuming equipment, it may still contain a sufficient amount of water hardness to cause boiler scale, priming, foaming, pitting or corrosion or caustic embrittlement.

There's no question about feed water conditioned by nature's own method discovered in the new TECHNICAL Water Conditioning System . . . a perfect balance of water's mineral content with correct, natural *organic substances.*

WATER CONDITIONING SYSTEM

TECHNICAL is a proven, natural system of individual formulas to fit each and every water type. It provides a special balance of water properties that definitely overcome scale, foaming, pitting, corrosion, priming, caustic embrittlement characteristic of boilers and condenser covering systems.

For your own satisfaction, investigate the new TECHNICAL System . . . Nature's own conditioning method developed under actual industrial operating conditions. Without obligation the coupon below will bring you the facts.

WATER TREATMENT COMPANY OF AMERICA

1159 Hodgkiss Street · Pittsburgh, Pa.

☐ Please send the new Technical System bulletin.
☐ Haye a Water Treatment Company engineer call.

Name_____ Title_____

Company_____

Address_____

Fig. 1. Transmitter

The only connection between the transmitter and the receiver is a single tube which can be bent to avoid intervening objects, or run through bulkheads with ease and safety. Cylinders in the transmitter and receiver are fitted with trunk type pistons and special packing glands designed to prevent fluid leakage. The single connecting tube and the cylinders of the transmitter and receiver form a closed system which is filled with a liquid of low freezing point.

Moving the handle of the transmitter through its arc causes a downward motion of the transmitter piston, forcing a definite quantity of fluid to pass to the receiver, thus moving the piston upward and causing the lever on the receiver to move through an equal arc. When the transmitter handle is returned to its original position, the fluid is forced from the receiver into the transmitter by pressure of a spring on the receiver piston, and the receiver is thus returned to its original position.

Fig. 2. Receiver

Equal and constant forces on each piston are provided by an internal arrangement of springs and rocker arms. The pistons are, therefore, balanced against each other. In the event of changes in the volume of the fluid resulting from extreme temperature changes, the relative starting position for the transmitter handle would vary with respect to the fixed starting position of the receiver handle. To correct for variations of this kind, a means for synchronizing the control is provided.

This is Synthetic Rubber

If America now has only a mere "handful" of natural rubber, it doesn't matter so much because synthetic rubber production is well on its way.

Pictured here is a handful of just one of the five basic commercial types of synthetic rubber—basic materials that are being turned into all of the things for which we used to rely on natural rubber.

Like natural rubber, the synthetic rubbers lend themselves to a great variety of processing treatments. Each type has distinct properties and characteristics that fit it for specific tasks.

For instance, one synthetic rubber, when treated a certain way, can be fabricated into the remarkable bullet-sealing hose which has so vastly increased the safety of our fighter plane and bomber crews . . . a different type, differently processed, may be the one that will produce rotary drilling hose for oil fields, or the compressed air hose for manufacturing plants.

Still other types of synthetic rubber may go into transmission or conveyor belts, mechanical packings, or any of the innumerable other mechanical rubber goods that serve on our battle fronts and in our war industries today.

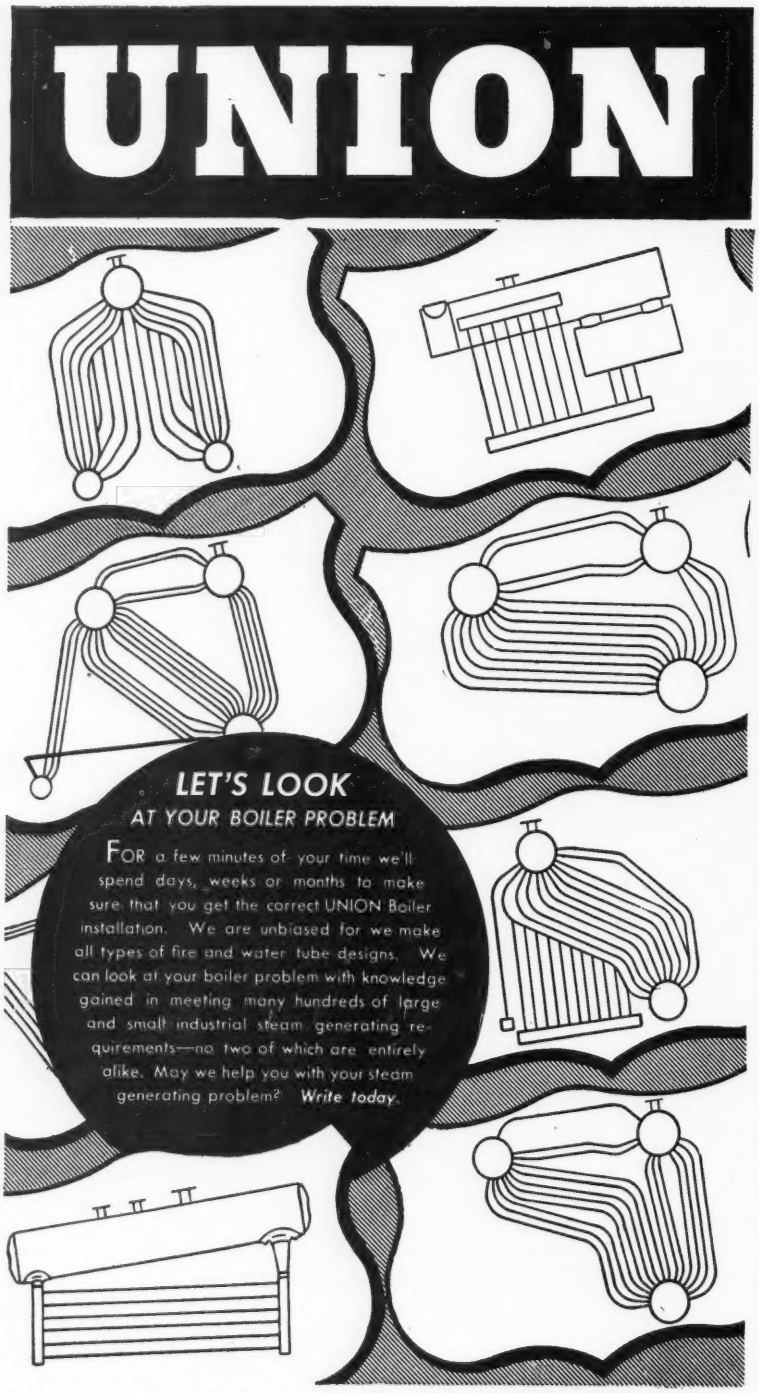
You need not worry about *this* type of synthetic rubber or *that* one. Your great good fortune is that they will be available—at hand for skilled and experienced hands to transform as needed into what is needed.

Since 1921 the United States Rubber Company has been experimenting with and developing the possibilities of synthetic rubber . . . has been in practical production of synthetic rubber products since 1931.

Listen to the Philharmonic Symphony program over the CBS Network Sunday afternoon, 3:00 to 4:30 E. W. T. Carl Van Doren and a guest star present an interlude of historical significance.

1230 Sixth Ave., Rockefeller Center, New York 20

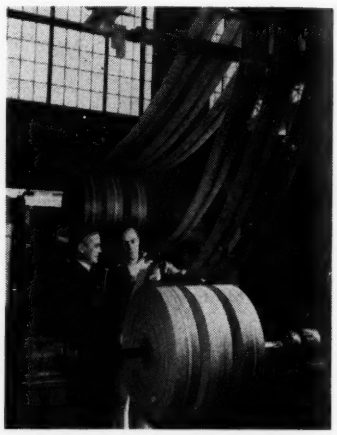
UNITED STATES RUBBER COMPANY


UNION
LET'S LOOK
AT YOUR BOILER PROBLEM
FOR a few minutes of your time we'll spend days, weeks or months to make sure that you get the correct UNION Boiler installation. We are unbiased for we make all types of fire and water tube designs. We can look at your boiler problem with knowledge gained in meeting many hundreds of large and small industrial steam generating requirements—no two of which are entirely alike. May we help you with your steam generating problem? Write today.
UNION IRON WORKS • ERIE, PA.
BOILERS
PRESSURE VESSELS • PLATE FABRICATION

Synthetic Rubber Belting

UNITED STATES RUBBER Co. has announced that volume production of industrial belting made with synthetic rubber has been started at its plant in Passaic, New Jersey.

This program of mass manufacture of synthetic rubber belting is designed to alleviate the shortage of transmission and conveyor belting which threatened war industries when sources of natural rubber were shut off with the capture of the plantations by the Japanese in the southwest Pacific.



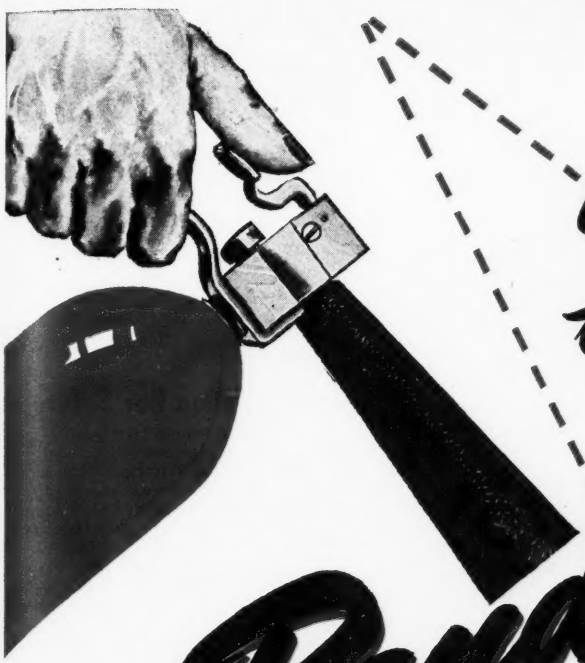
Cotton fabric which forms the base of the product is made in various weights at the textile plants of the company and shipped to the Passaic plant for processing. This method consists of the application of synthetic rubber being forced into the pores of the fabric through the use of rollers. It is then fabricated into whatever sizes are necessary to meet the desired requirements.

Vulcanizing consists of a heat treatment which reaches a temperature of 287 F. The entire fabricating process depends on the work for which the belt is designed.

New Type Synthetic Rubber

UNITED STATES RUBBER Co. has announced that a new synthetic rubber, the sixth major type to be discovered through chemical research, has been developed by the General Laboratories of the company. This new synthetic, known as Uskol, will be used in both industrial and household products. As a result of its distinctive properties, it is expected to take its place alongside the present five commercial types of synthetic rubber—buna S, buna N, neoprene, butyl and thiokol.

Uskol offers a new high degree of resistance to solvents and will be used in the manufacture of commodities which come into contact with fuels, oils, gasoline, dry cleaning fluids and other penetrating chemicals which are the enemies not only of natural rubber but of the other five synthetic types. It will also be used for specialties such as industrial molded items, tubing, gas and oil hoses, tank linings, and for application to paper and cardboard to render them resistant to grease, water and chemicals. It is not applicable to tires but it can replace in various items



FREEZE that FIRE!

with the Randolph "4"

CARBON DIOXIDE FIRE EXTINGUISHER

Model FF4-V

The Right Extinguisher—For flammable liquids—motors—electric fires—the Randolph "4" carbon dioxide unit is the fast and safe extinguisher—instantly discharges a penetrating, icy blanket of gas that freezes and smothers the fire completely, preventing its spread and damage to material.

In The Right Place—Convenient, portable, light, the Randolph "4" is quickly available. Detaches easily from its wall bracket. Guards periodic work that is fire hazardous. The Randolph "4" provides positive protection—it gets to the fire before the fire gets a start.

Quick to Operate—No valves to turn, hoses to adjust, horns to swing up, the Randolph "4" is panic proof—aimed and operated with one hand—the rigid horn permits accurate aim and control—a touch of the thumb—and the fire is out!

Leaves No Trace—Randolph "4" carbon dioxide gas is clean and harmless—not a trace of deposit, stain or contamination remains to injure machines, affect electric motors, damage material or destroy chemical formulae. **Convenient to Get**—Prompt delivery to all essential industries. Your supply house probably has the Randolph "4." If not—write, telephone or wire—

RANDOLPH LABORATORIES, INC.

8 EAST KINZIE STREET • CHICAGO 11, ILLINOIS, U. S. A.

other synthetics which can be used in tires.

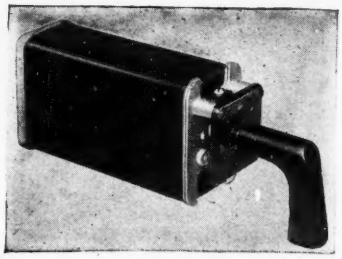
Uskol, according to the manufacturer, can be vulcanized in several ways to acquire high physical properties; it has high tear resistance exceeding that of natural rubber; it can be used alone or as a blend with other synthetics; it is more resistant to the effects of sunlight, ozone, and oxygen than any other synthetic rubber; it has no odor either in the raw material state or in the finished product; it can be produced with present machinery and it is easy to handle during manufacture.

This new synthetic resulted from search for a rubber which would provide greater resistance to attack of high octane aviation gasoline. Its use will be limited to war products.

Master Control Switch

A NEW MASTER CONTROL SWITCH for heavy-duty service is announced by the General Electric Company. Designated Type SB-9, it is for use wherever repetitive operations of electrically operated devices run into many thousands per week. For example, it is especially serviceable in steel mills for opening and closing control circuits from the control desk.

The new switch can be mounted on panels varying in thickness from ⅛ in. to 2 in. It is rated at 600 v, 20 amp continuous, or 250 amp for 3 sec. Its interrupting rating is dependent upon the voltage and character of the circuit, and upon the number of contacts arranged in series. A table of interrupting ratings, as well as a



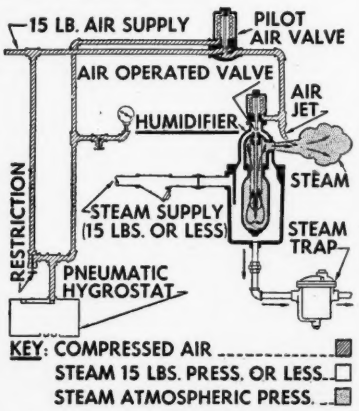
detailed description of the Type SB-9 switch and its features, is contained in Bulletin GEA-4114, available on request to General Electric, Schenectady, New York.

Humidification For Safety

ORIGINALLY developed for process industries where the moisture content of materials is of importance in handling and manufacture, steam type unit humidification has been found highly valuable also in preventing fires and explosions caused by static electricity. Static hazards increase greatly during the winter heating season when indoor humidities are very low.

A special unit humidifier operated by compressed air has been developed for use in places where there are mixtures of air and gas, or air and dust, or where explosive materials are in process.

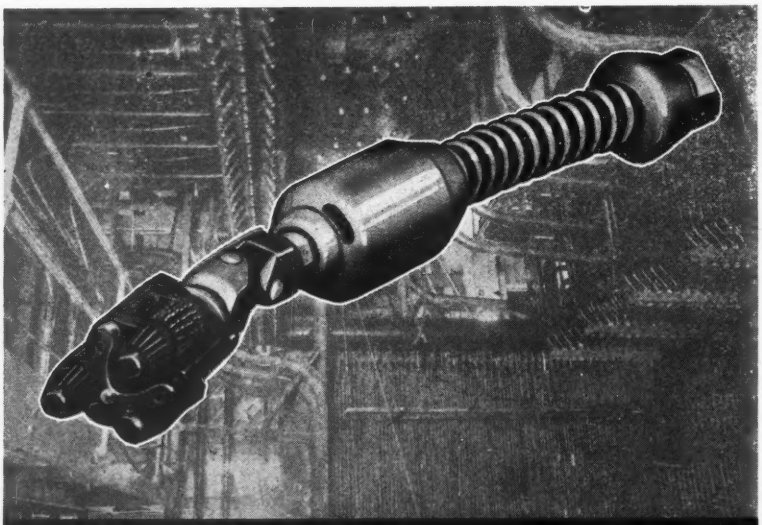
As shown by the diagram, this humidifier uses compressed air in connection with a humidistat to control the steam valve on the humidifier when required, and to disseminate the exhaust steam into the atmosphere by air blast. With this arrangement there is no sparking hazard, as with electrically operated units.



The cost of humidification with this type of equipment is said to be very low, amounting to less than two cents an hour for 40,000 sq ft of area. A bulletin (No. 158) covering the engineering aspects of steam type humidification is available upon request to the Armstrong Machine Works, Three Rivers, Mich.

Engine-Driven Fire Pumps

FAIRBANKS, MORSE & Co., Chicago, Ill., has announced a new line of gasoline engine-driven fire pump units in capacities of 500, 750 and 1000 gpm. These units will provide fire protection if electric power or steam pressure becomes unavailable and an emergency standby protection



GIVE YOUR TUBES A "BREAK"—
USE WILSON TUBE CLEANERS!

Sound engineering practice and good business policy demand that tubes be kept clean and this requires the use of the right tube cleaning equipment.

Different tubes and different deposits require different types of tube cleaners. Wilson ETC cleaners are especially recommended for cleaning bent tubes because they have "what it takes."

The Wilson line of tube cleaning equipment is so complete and so up-to-date that you can easily select the most suitable cleaner and accessories to *quickly, thoroughly* and *economically* clean *any* straight or bent ferrous or non-ferrous tubes of large or small diameter.

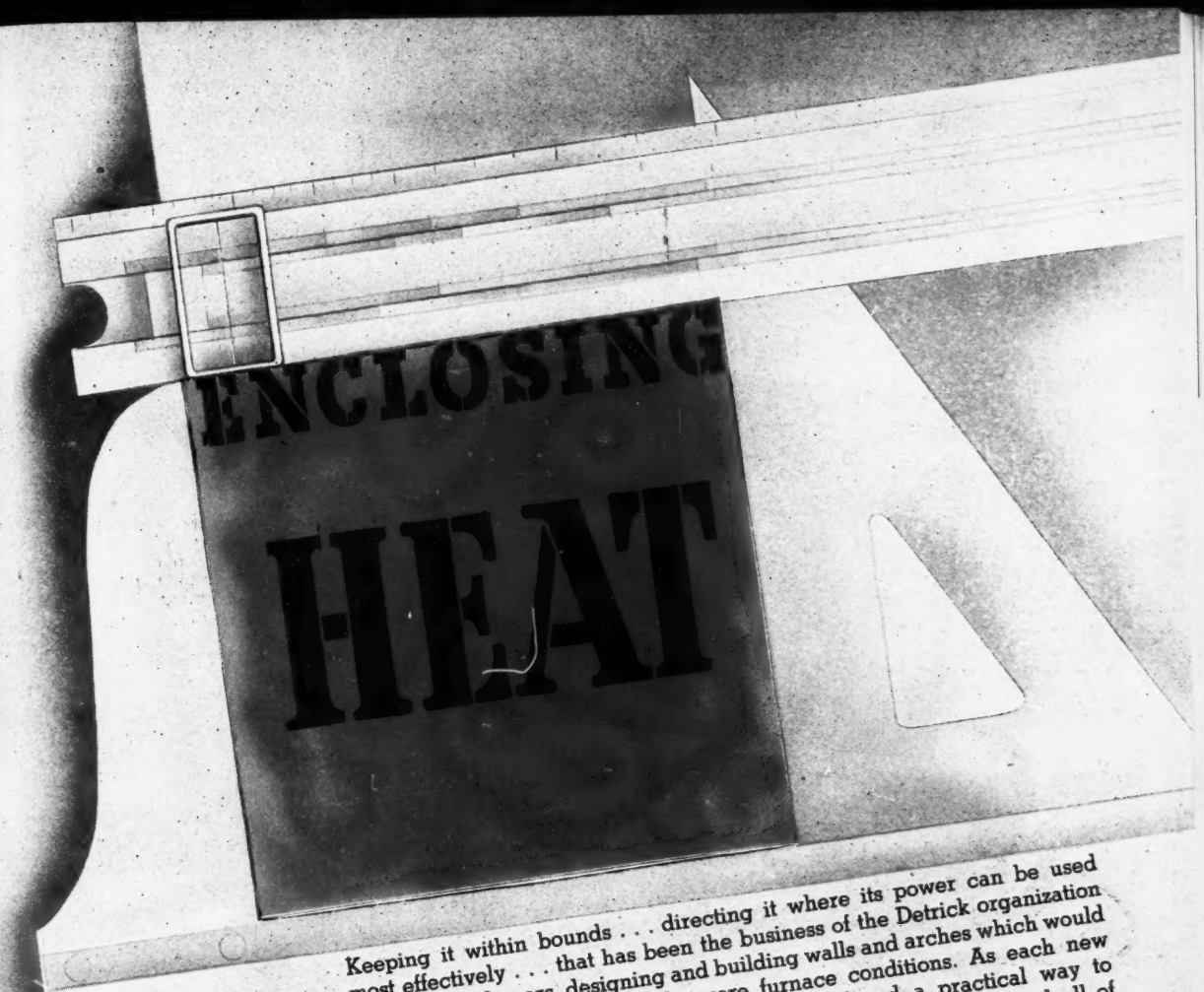
Power plants, war plants, refineries, ships and ship-yards are using Wilson tube cleaning equipment because it has demonstrated its ability to do an outstanding job of tube cleaning, even under the most arduous war-time operating conditions.

Write for the name of our representative nearest to you, or ask for a copy of our 40-page catalog, which fully describes and illustrates the complete line of Wilson tube cleaning equipment.

Representatives in all Principal Cities.

BACK THE ATTACK! BUY WAR BONDS AND STAMPS!

THOMAS C. WILSON, Inc.
PIPE AND TUBE CLEANERS EXCLUSIVELY
THE WILSON BUILDING
21-11 44TH AVE. LONG ISLAND CITY, N.Y.



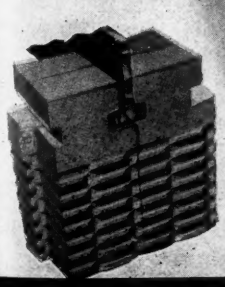
Keeping it within bounds . . . directing it where its power can be used most effectively . . . that has been the business of the Detrick organization for the past 30 years, designing and building walls and arches which would stand a high temperature and severe furnace conditions. As each new problem was presented by industry, Detrick found a practical way to meet it until today thousands of furnaces are serving industry and all of its branches equipped with

DETRICK SUSPENDED ARCHES AND WALLS

It is because of the application of sound engineering principles which Detrick has learned from practical experience, that their arches and walls give such long, economical service. One of these principles is the Detred Tile with treads on all four sides which hold the wall together vertically and horizontally and serve to keep it airtight during its long life. A method of sectionally supporting walls, so that the load is transferred from the tile to metal supports, also contributes to the economy in maintenance.

There is a Detrick construction especially suited for each type of furnace —for steam boilers, for oil heaters, for steel heating furnaces, etc. Each has its own problems which are met by a type of Detrick construction.

The results of these thirty years of experience have been gathered together in what is practically a textbook on the subject of enclosing heat. With charts, photographs, drawings and illustrations the engineer can bring himself up to date on this important subject. If you have a furnace problem, now, or one in the future we shall be glad to send you a copy of this booklet on request. Ask for DETRICK FURNACE ENCLOSURES.



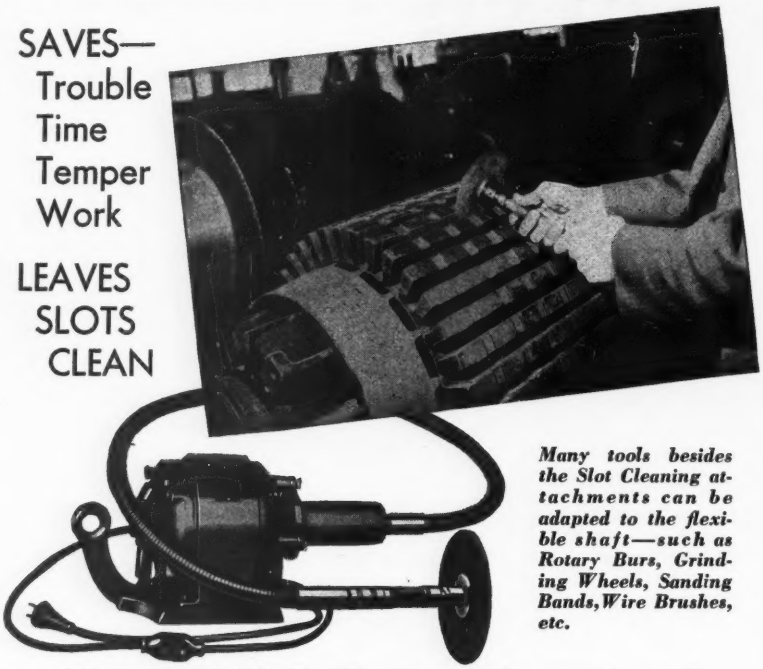
DETRICK
FURNACE ENCLOSURES

M. H. DETRICK COMPANY
140 SO. DEARBORN ST.
CHICAGO, ILLINOIS

For Quick, Easy Armature Slot Cleaning use a MARTINDALE SLOT CLEANER

SAVES—
Trouble
Time
Temper
Work

LEAVES
SLOTS
CLEAN



Many tools besides the Slot Cleaning attachments can be adapted to the flexible shaft—such as Rotary Burs, Grinding Wheels, Sanding Bands, Wire Brushes, etc.

Using a Martindale Slot Cleaner not only saves time and trouble it assures a better job of armature rewinding for it removes all sharp projections, burrs, etc., that might puncture or tear the slot lining or coil insulation. Also, quickly removes old solder from the riser slots.

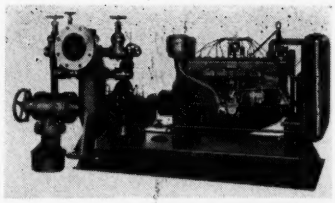
The flexible, non-breakable discs eliminate all danger to the operator.

Available with various types of motors and accessories.

The Cleaner and many other items of Electrical and Maintenance Equipment are fully described in Catalog No. 24. Send for a copy today.

THE MARTINDALE ELECTRIC CO.
1432 HIRD AVE. CLEVELAND 7, OHIO

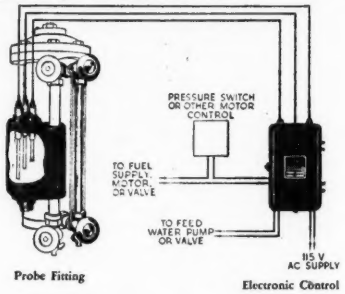
BACK THE ATTACK WITH WAR BONDS



to supplement electric motor-driven or steam turbine-driven fire pump units; quick and reliable starting comparable to automobile starting; full engine developed horsepower available in a minimum of time; may be equipped for automatic operation starting from pressure switches or thermostat; and economical cost is claimed by the manufacturer, contrasted with larger marine type engine-driven fire pump units. Two or three or more such standardized units can be installed to advantage to obtain a desired total capacity.

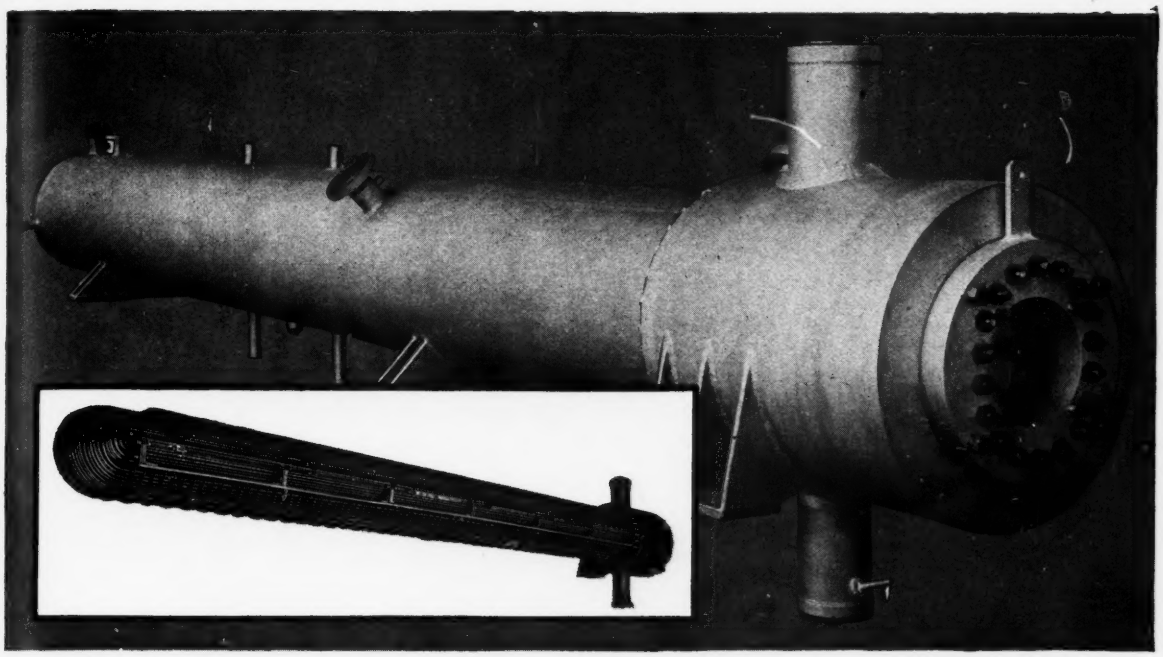
Boiler Level Control

COMBUSTION CONTROL CORP., Cambridge, Mass., announces "Fireye" a new feedwater level controller, series P156N, for maintaining constant boiler water levels automatically, and for guarding against low-water hazards. Designed to provide the average power plant with low-cost automatic control, the equipment eliminates difficulties encountered with complicated mechanical devices and is guaranteed for an unlimited service-free life.


PRESSURE SWITCH OR OTHER MOTOR CONTROL
TO FUEL SUPPLY MOTOR OR VALVE
TO FEED WATER PUMP OR VALVE
115 V AC SUPPLY
Probe Fitting
Electronic Control

Typical FIREYE Installation For Automatic Boiler Feedwater Control And Low-Level Safeguard

For automatic feedwater pump control and low-water protection, this controller is used with Probe Fitting Type H53. The probe fitting may be mounted parallel to the water column, or directly on the boiler, and is wired to the electronic control. Three probes within the casing mark boiler feedwater pump on and off levels and a low-water danger point. The top and middle probes determine the high and low levels at which the boiler feedwater pump is turned on and off to maintain constant water level. When water falls below the middle probe, it closes the electrical circuit controlling the pump and water feeds into the boiler. When the level rises to the top probe, the water itself acts as conductor of a minute electrical current which operates an electron tube relay which turns off the pump. The pump remains inoperative until boiler water again falls to the level of the middle probe. The lowest probe defines the danger point below which boiler water must not fall. Should water drop below this safety probe, the control immediately shuts off the fuel supply and sounds an alarm.



This G-R STAGE HEATER combines

SIMPLICITY... because the U-tube construction and tube sheet integral with water head requires a minimum of high pressure joints.

RUGGEDNESS... because of sturdy construction; including ample support of tubes, and prevention of vibration by minimum clearance at tube support plates.

ACCESSIBILITY... because the only high-pressure joint is a single manhole cover.

The design and construction of this unit is based on 76 years of experience in building heat transfer apparatus.

The Griscom-Russell Co.
285 Madison Avenue
New York 17, N.Y.

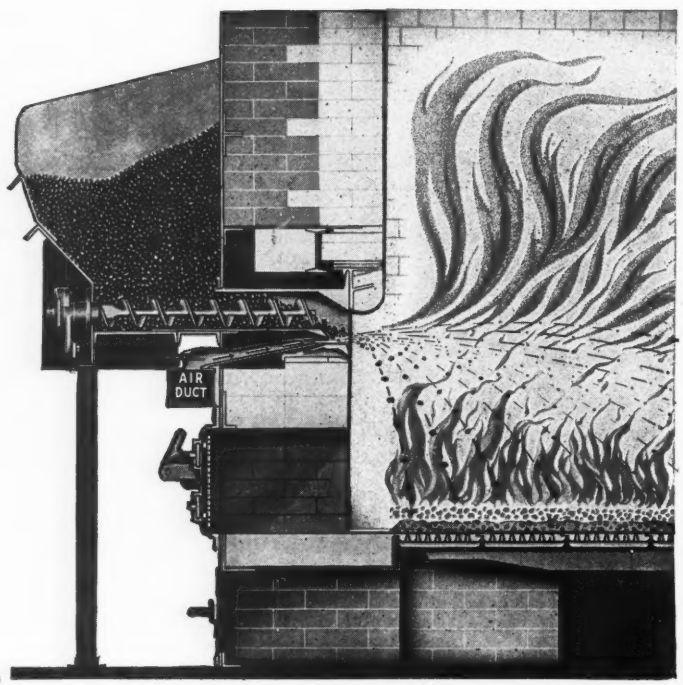
Write for Bulletin

THE GRISCOM-RUSSELL CO. 285 MADISON AVE. NEW YORK 17, N. Y.

GRISCOM-RUSSELL

Pioneers in Heat Transfer Apparatus

Install the stoker that burns Local, Low-cost, Low-freight Coals!



DON'T penalize yourself with equipment that requires special high priced coal, when you can convert with **FYR-FEEDER** stokers that burn any kind of bituminous coal you have available locally—from 1½" screenings down to yard sweepings.

STEP UP PRESENT BOILER CAPACITY. WPB is granting priorities for **FYR-FEEDER** stokers to plants requiring additional steam generating capacity. In a great many cases these stokers make it unnecessary to add another boiler to handle an increased load. **FYR-FEEDER** features: suitable for large or small boilers . . . low maintenance . . . low power requirements . . . maximum active coal burning area (no dead plates) . . . easily accessible multiple feeding units . . . large hopper capacity . . . accurate over-fire air control . . . no clinkers (thin fuel bed).

***ASK FOR CATALOG** illustrating operation, design and typical installations. Write today.*

QUICK DELIVERY

FYR-FEEDER stokers can be installed with minimum loss of production time, without major alteration to present boiler equipment. Made by a company that has specialized on overfeed and spreader stokers for 25 years. Widely used by nationally known concerns.

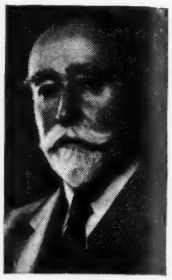
FYR-FEEDER MULTIPLE SPREADER STOKERS BURN COAL LIKE OIL

AMERICAN COAL BURNER COMPANY
ENGINEERS • ESTABLISHED 1918
Builders of thousands of Industrial Stokers

22-18 E. Erie St. **Chicago 11, Illinois**

OBITUARIES

J. Frank Nickerson



J. FRANK NICKERSON, oldest active trade paper publisher in the United States and international authority on refrigeration, died October 20 at his home in Chicago at the age of 82. Until illness interrupted his work recently, Mr. Nickerson had continued as president and active head of Nickerson & Collins Co.

Fifty-two years ago, in 1891, he started publication of "Ice and Refrigeration" magazine. He continued as its editor and publisher up to the time of his death. The company also publishes "The Refrigeration Service Engineer" and a number of books on refrigeration subjects.

Since its organization in 1909, he had been general secretary of the American Institute of Refrigeration which is the representative organization of the industry in the United States. A delegate and attendant at the several meetings of the International Congress of Refrigeration he had a large share in setting up the organization and placing it on an effective operating basis. He was the principal organizer of the National Association of Practical Refrigerating Engineers on a national basis and throughout the years was active in expanding the work of that organization. He was also an honorary member of the American Society of Refrigerating Engineers and active in the affairs of the National Association of Refrigerated Warehouses, as well as numerous state and sectional associations in the refrigerating field.

In 1917, during World War I, he joined with other leaders in the ice industry to organize the National Association of Ice Industries. He served on various committees of that organization from time to time.

In 1933, as a result of his personal efforts, the Refrigeration Service Engineers Society was organized and he became the publisher of "The Refrigeration Service Engineer," official journal of that Society.

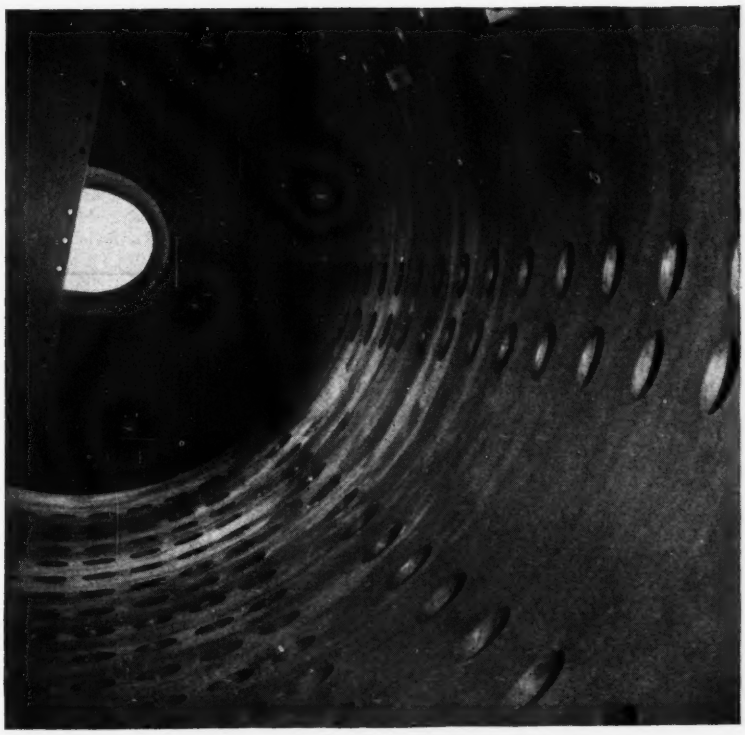
Charles B. Davis

CHARLES B. DAVIS, former manager of General Electric's New England district who retired October 1, 1926, died October 22 at his home in Boston after a short illness. He was 82 years old.

Mr. Davis was born in Lexington, Mass., January 2, 1861. He attended the Lexington public schools, high school, and a private preparatory school, and was graduated from Harvard University in 1884 with the degree of A.B., magna cum laude.

When Mr. Davis retired 17 years ago, he had been in the continuous service of General Electric Co. and its associates for 42 years. Employed in 1884 by the Thomson-Houston Electric Co. at Lynn, Mass., one of the forerunners of G.E., Mr. Davis's first job was filing steel castings.

YEARS OF EXTRA LIFE FOR OLD BOILER METAL



APEXIOR Protective Coating adds years of active service to any boiler that can pass inspection and a hydrostatic test.

Before you condemn that "worn-out" boiler — practically irreplaceable today — find out whether APEXIOR can keep it on the line for years' more useful life.

Hundreds of prominent power users have kept their "veterans" in service at top ratings during the present emergency by applying APEXIOR after testing and cleaning.

It's *available* — we have enlarged our facilities to meet the metal shortage. It's *recommended* by boiler insurance companies. It's *economical* — let us quote you figures. And, above all, *it keeps those war-essential veterans on the line* — for the duration!

3 Easy Steps In APEXIORIZING Old Metal Against Wear, Corrosion

(1) Inspect and give boiler hydrostatic test. (2) Clean to bare metal. (3) Apply APEXIOR with a brush, by hand or power-coater.

You'll find APEXIOR (1) provides a tough, impervious barrier against boiler water, (2) prevents corrosion for as long as 2 to 3 years, and often longer between renewals, (3) prevents direct bonding of dirt and scale, being thus easy to renew after quick cleaning with a wire brush.

Before condemning any boiler, *test and APEXIORIZE.* It's the quick, low-cost mechanical way to add years of extra life to boilers in war service. Write for free bulletins 1290 (General), 1305 (Marine) with complete data.

A Few APEXIOR Customers

Over 80% of all orders for APEXIOR are repeat orders

War Shipping Administration
Defense Plant Corporation
Standard Oil Co. of New Jersey
Republic Steel Co.
Owens-Illinois Can Co.
Kaiser Co.
Ford Motor Co.
Philadelphia Electric Co.
Chicago Great Western Ry. Co.
Virginia Electric & Power Co.

APEXIOR

A Peacetime Plus ★ ★ ★ A Wartime Must

RECOMMENDED BY ALL U. S. AND CANADIAN BOILER INSURANCE COMPANIES

The **DAMPNEY COMPANY of America**
protective coatings for
STATIONARY BOILERS, LOCOMOTIVES AND STEAMSHIPS

THE DAMPNEY COMPANY OF AMERICA
Hyde Park, Mass.

Please send me free Bulletin 1290 (industrial)..... Bulletin 1305 (marine).....

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Engineering Sales Representatives — Pittsburgh, Cincinnati, New Orleans, San Francisco, Los Angeles, Portland, Seattle, Phoenix, Denver, Salt Lake City, Dallas, Houston, Vancouver, B. C., Montreal, P. Q., Havana, Cuba, Manila, P. I., Honolulu, T. H., Marine Dept., 114 Liberty Street, New York, N. Y.

59 years
of knowing how to make tight seals

Chesterton Parachute Packing—the improved packing that requires no gland pressure and is truly automatic—is the fine fulfillment of 59 years of practical experience in overcoming thousands of intricate pressure seal problems. Specify Parachute Packing and watch your plant maintenance costs drop. Sold in all principal cities by Factory-Trained Distributors. Write for Catalog 20-E. It includes useful Packing-Selector chart, answers many packing questions.

A. W. CHESTERTON CO.
64 INDIA STREET • BOSTON, MASS.

CHESTERTON
Parachute Packing
FULLY AUTOMATIC • NO ADJUSTMENTS

CHANGE OF ADDRESS

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POWER PLANT ENGINEERING

When the Thomson-Houston and Edison General Electric companies were merged in 1892 to form General Electric, Mr. Davis became the assistant manager of the new company's Boston office. The following year he became manager, succeeding E. I. Garfield. As the company grew larger, Mr. Davis's territory expanded and at the time of his retirement on October 1, 1926, he was manager of the New England District with headquarters in Boston.

George F. Morrison

GEORGE F. MORRISON, director of General Electric Co. since 1922, honorary vice president of the company and an Edison pioneer, died October 21 at his home in East Orange, N. J., at the age of 76. He was a leader in the incandescent lamp field.

Mr. Morrison was born in Wellsville, N. Y., February 22, 1867. He attended the public schools there and at Harrison, N. J., until the beginning of his employment at the Edison Lamp Works.

Early in 1882, the year in which Thomas A. Edison began the operation of the first generating station that supplied electric current for incandescent illumination, Mr. Morrison, as a lad of 15, sought and secured employment at Edison's Harrison plant.

During the years that followed, he worked in practically every department of the lamp works. Eventually he was appointed foreman of a small department, later of a larger one, and finally of the largest and most important in the plant. His subsequent successive advancements were to the positions of general foreman, superintendent, and works manager in 1900.

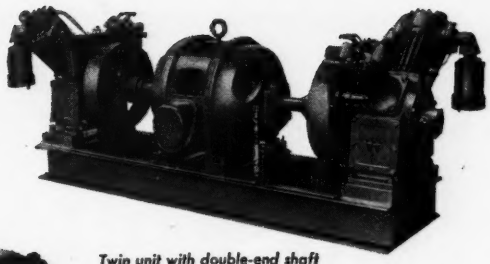
In 1916 he was elected a vice president of General Electric in charge of the Edison lamp division of the company's incandescent lamp interests. He was elected to the board of directors in 1922, and in 1928 was made an honorary vice president. He then relinquished his active supervision of the company's lamp business. Mr. Morrison was also a director of the International General Electric Co. and other companies.

MANUFACTURERS' PERSONALS

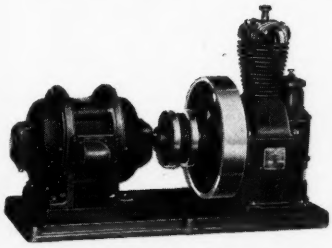
C. V. Topliffe has been appointed manager of the Boston District Office of Cutler-Hammer, Inc., of Milwaukee, Wis. Mr. Topliffe started with Cutler-Hammer, Inc., in 1924 at the main plant, immediately after he graduated from Cornell University. Later Mr. Topliffe was transferred to the sales staff. During this time Mr. Topliffe's experience has been quite extensive in the application of the Company's diversified line of apparatus.

In the Boston area he has been associated with W. E. Addicks, who moves to New York as the District Manager there.

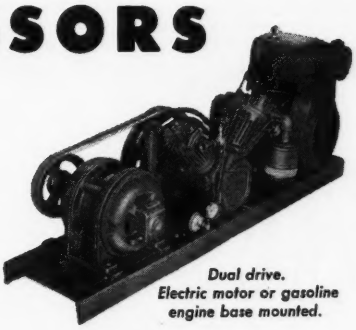
WORTHINGTON Vertical COMPRESSORS



Twin unit with double-end shaft motor on steel base



Unit direct connected to electric motor



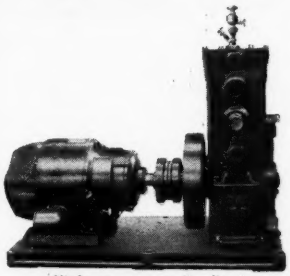
Dual drive. Electric motor or gasoline engine base mounted.

24 Sizes

344 Arrangements

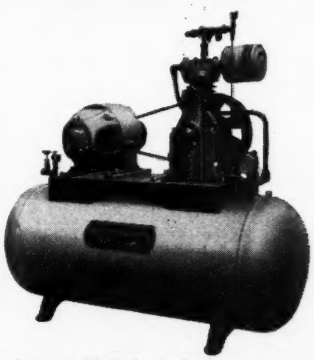
Capacities to 164 c.f.m.

Pressures to 1000 lbs.



High-pressure unit direct connected to electric motor

War production plants are now using these units in a total of more than two million horsepower. To any plant whose needs for compressed air fall within the above range, Worthington compressor equipment offers advantages that can contribute greatly to stepped-up output. They are built for users who demand the best equipment.



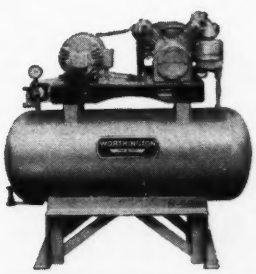
Tank-mounted belted unit showing pressure regulator control

The following features make Worthington compressors the choice of careful purchasers.

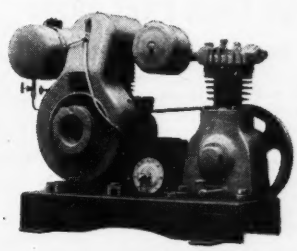
- One-piece Feather Valve . . . lightest, simplest, most efficient.
- Close-grained nickel iron cylinder, honed to mirror surface . . . generously finned for efficient cooling.
- Ground piston, closely fitted in cylinder . . . two compression rings and two oil rings . . . for oil-free air discharge.
- Full-floating wristpin . . . retainer spring prevents scored cylinder.
- Extra-long drop-forged heat-treated connecting rod . . . reduces cylinder wear. Shim-adjusted babbitt crankpin bearing. Graphite-bronze wristpin bushing.
- Drop-forged heat-treated integrally-counterbalanced crankshaft . . . journals ground and polished.
- Adjustable Timken main bearings . . . controlled splash lubrication.
- Force-feed lubrication to all shaft bearings . . . adjustable babbitt main bearings.
- Shaft oil-seal keeps compressor installation clean and oil-free.
- Crankcase ventilator . . . well baffled . . . keeps oil in, and dust out.
- Cast-iron belt wheel with fan spokes . . . good cooling decreases power required.

Worthington vertical compressors are available to those manufacturers whose war production activities give them priority. An authorized Worthington industrial dealer or district office engineer will be glad to assist you with the correct selection for your requirements.

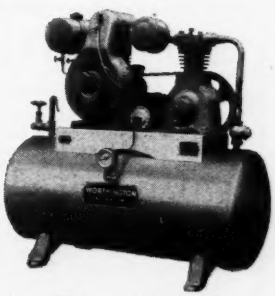
Unit mounted on Massachusetts code vertical tank



Massachusetts code horizontal tank-mounted compressor unit



Base-mounted unit with gasoline engine drive



Tank-mounted unit with gasoline engine drive

AC3-1A

WORTHINGTON PUMP AND MACHINERY CORPORATION • HARRISON, NEW JERSEY

Get Old Valves Back On Their Feet Again

—at less than half of the new valve cost

FOR VICTORY'S SAKE reclaim all your Iron, Steel or Brass valves. Every old valve put back in service means that another new one is available for vital war industry—to keep production lines flowing.

Send us those leaky old gate and globe valves you had planned to discard. Our experienced "Valve Doctors" will repair worn seats, discs and other parts. Our charges never exceed 50% of the original valve price; and they usually run around 35%. We pay shipping costs both ways on valves that can't be fixed.

For Victory, Salvage Old Valves—Send Them To

THE COMBUSTION EQUIPMENT & INSULATION CO.

Factory at Greenlawn and Erie R. R. Tracks, Lima, Ohio

R. H. Rodolf has been appointed manager of the Pump and Compressor Division of Gardner-Denver Co., Quincy, Ill., following the death of R. J. MacFarland. Mr. Rodolf's connection with the company dates back to August, 1917. C. M. George has been appointed assistant to Mr. Rodolf.

Walter J. Ewbank has been appointed Chief Engineer for the Briggs Clarifier Co., Washington, D. C. In addition to the normal duties of a Chief Engineer, Mr. Ewbank heads a department which has recently been created in a reorganization plan designed to promote more thorough cooperation between the Sales and Engineering Departments. Prior to joining the Briggs Clarifier Co. in 1938 Mr. Ewbank attended Purdue University and Virginia Polytechnic Institute.

H. W. Tenney, formerly Assistant Director of the Westinghouse Research Laboratories, has been named assistant to Thomas I. Phillips, vice president in charge of the company's Pittsburgh Divisions. In his new position Mr. Tenney will help coordinate vital wartime engineering activities.

E. A. Bertram has recently been appointed General Manager of Heat Transfer Products, Inc., New York, N. Y. Prior to his new association he was Chief Engineer of the Heat Exchanger Department, The Lummus Co., New York, N. Y., and was previously connected with Alco Products, Inc., and Shell Oil Co. Mr. Bertram is a graduate of the University of Illinois and also received a master's degree in Chemical Engineering from the California Institute of Technology.

The appointment of Peter L. Lenz as Manager of the Middle Atlantic District Manufacturing and Repair Department of the Westinghouse Electric and Manufacturing Co. was announced recently by Mr. H. F. Boe, vice president of the company. Mr. Lenz, who was formerly manager of the Homewood Manufacturing and Repair Plant, Pittsburgh, will make his headquarters in Philadelphia. His new duties will include general supervision of two manufacturing and repair plants in Philadelphia, one each in Wilkes-Barre, Pa., Huntington, W. Va., and Baltimore, Md.

Announcement is made by Jenkins Bros. that J. Murray Whitworth has been appointed to the Pittsburgh area as a sales representative of the company. He succeeds John J. Simpson who resigned to become general sales manager of Pittsburgh Gage & Supply Co. Mr. Whitworth, a graduate of Rhode Island State College, has been connected with the company's Philadelphia branch for the past seven years as a representative in Baltimore, Md., and Harrisburg, Pa. In Pittsburgh he will be associated with L. V. McCune.

Wallace K. Brown, former vice-president in charge of Procurement for the Crocker-Wheeler Electric Mfg. Co., has been made Manager of the New York District sales of the Crocker-Wheeler Division of the Joshua Hendy Iron Works office. Mr. Brown first came with the Crocker-Wheeler Electric Mfg. Co. in 1908 as an apprentice engineer, after completing his technical training at Clarkson College of Technology and the University of Illinois. Since that time

THE POWER BEHIND THE BATTLE LINE...

that puts the weapons of victory in the hands of fighting men around the world

Bombers, tanks, shells, bazookas—all the thousand and one items of supply vital to the war—pour out of America's factories in tremendous quantities . . . Ships go down the ways at a rate the world had not even dreamed of . . .

And to back the great attacks now beginning, America's war production must rise to still greater heights this year.

The entire TODD COMBUSTION EQUIPMENT organization is proud to be playing its part in this mighty effort.

For 30 years TODD burners have won for themselves a unique reputation for continuous and efficient production of power and heat, both on land and sea. Since Pearl Harbor, TODD has met, and is now constantly meeting, the enormous demands for efficient combustion equipment for new and converted war plants, and the rapidly growing Navy and Merchant Marine!

All TODD burners today are on high priority. But when victory is won, the company will again serve the many organizations who today cannot obtain combustion equipment—commercial buildings, plants manufacturing civilian goods, churches and schools.

New research development, born of the war, will enable TODD to provide still greater efficiency and economy in boiler plant operation on both land and sea.

TODD SHIPYARDS CORPORATION

TODD COMBUSTION DIVISION

601 West 26th Street, New York 1, N. Y.

ARMY E NAVY

NEW YORK ★ MOBILE ★ NEW ORLEANS ★ GALVESTON
SEATTLE ★ BUENOS AIRES ★ LONDON

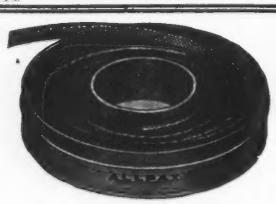
Turn every heat unit into useful power or heat! Fuel waste is sabotage.

Increase Your Manpower with ROTO TUBE CLEANERS

One-man operation saves labor and time

Roto Tube Cleaners, equipped for one-man operation, are relieving the acute shortage of help in hundreds of plants throughout the country. An air valve on the motor permits the operator himself to control the air, eliminating the need for a helper, and saving time-loss due to signalling. Roto offers you the kind of tube cleaning performance that you need to meet today's critical requirements.

The ROTO Company
145 Sussex Ave., Newark 1, N. J.



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THE PACKING THAT "PACKS ALL"

. . . use it once and
. . . you'll use it always

THE ALLPAX CO., INC.
Mamaroneck, N. Y.

•

Distributors Everywhere

Here's the universal packing that can be used for any fluid or on any apparatus—economically, efficiently—tightly—simply.

Try ALLPAX and you, too, will be enthusiastic over its easy application and long wear. You don't have to remove old packing to repack with ALLPAX. Square cross section makes ALLPAX easy-filling in any stuffing box.

Try it and you'll always use it. Full details on request.

he has been district manager in San Francisco and Newark and Eastern Sales Manager in New York.

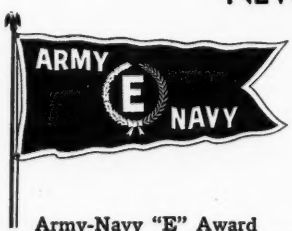
E. H. Fritschel has been named Sales Manager of Transmitting Tubes, and H. J. Mandernach, Sales Manager of Receiving Tubes in the Tube Division of the General Electric Company's Electronics Department. Both men are located in Schenectady, N. Y.

Harold I. Beadle, chemical engineer, has been appointed sales manager for new products of Naugatuck Chemical Division, United States Rubber Co. In this capacity Mr. Beadle will handle sales of new synthetic rubbers and synthetic plastics for the rubber company and also new developments of the company in other chemical fields being explored by the company. Mr. Beadle was graduated at Massachusetts Institute of Technology in 1923 with a degree in chemical engineering and practiced as a consulting engineer in New York City for six years. He then was employed by Tide Water Associated Oil Company as product development engineer, and later as special representative in charge of sales throughout New England. Later he joined the organization of Commercial Investment Trust, Inc., in charge of engineering investigations in the states of Pennsylvania, New Jersey, Maryland and Virginia.

M. P. Nickerson has been appointed General Apparatus & Supplies Manager at headquarters office of Westinghouse Electric & Mfg. Co. in New York, with complete responsibility for the development, coordination and promotion of apparatus business nationally.

T. O. Eaton has been appointed Manager Sales, Power Transformer Section, at General Electric's Pittsfield Works, according to an announcement by L. R. Brown, Manager of the Transformer Division, Central Station Divisions. E. D. Monk, Mr. Eaton's predecessor, who has been with the company 34 years, will continue as a member of the section for consultation and special duties.

MANUFACTURERS' NEWS



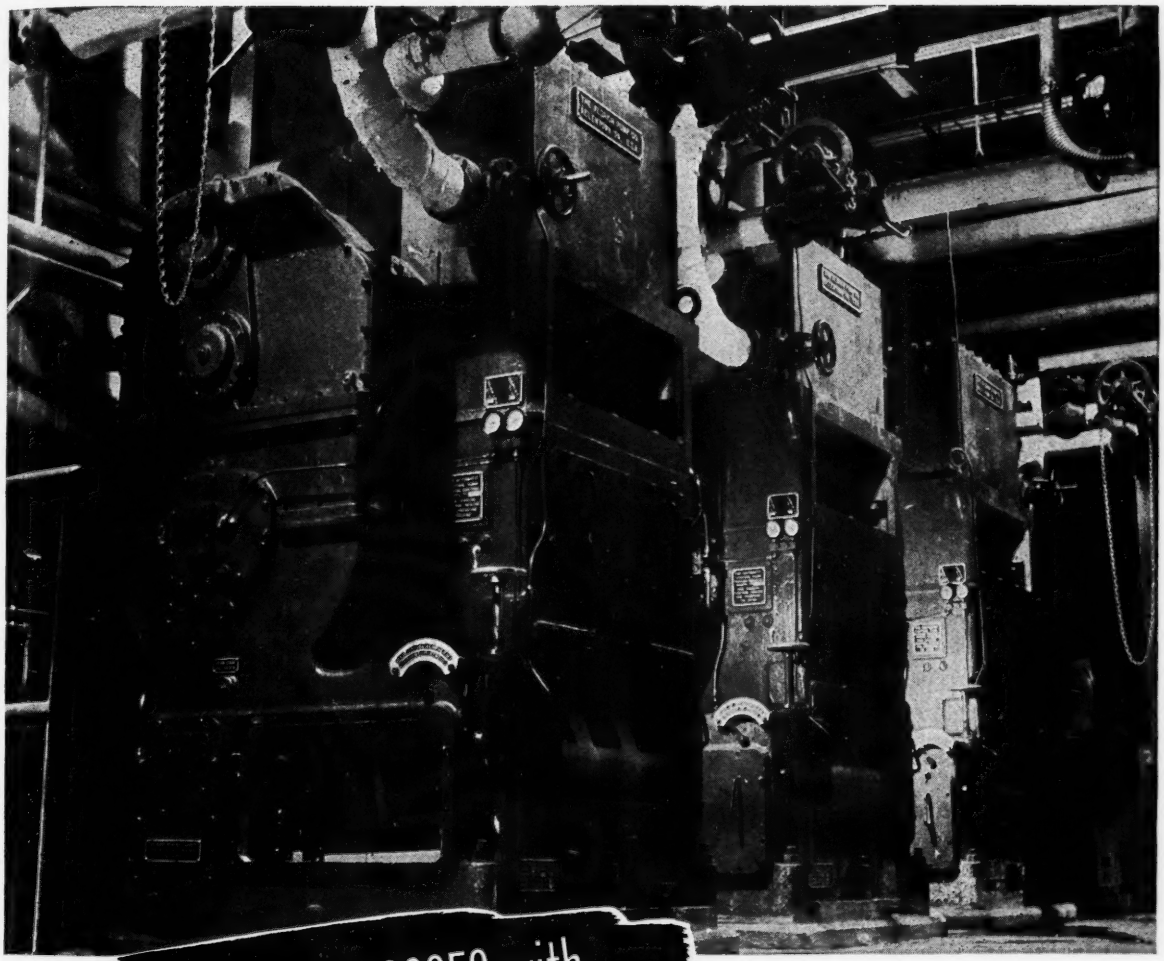
Army-Navy "E" Award

American Foundry Equipment Co.*
Mishawaka, Ind.
Askania Regulator Co.
Chicago, Ill.
Briggs Clarifier Co.
Bethesda, Md.
A. M. Byers Co.*
Pittsburgh, Pa.
Fitzgibbons Boiler Co., Inc.
Oswego, N. Y.
The Mathieson Alkali Works, Inc.*
Niagara Falls Plant
Philco Corp., Storage Battery Div.*
Trenton, N. J.

Maritime Commission "M" Awards

The Wm. Powell, Co.*
Cincinnati, Ohio

*Star added for sustained high achievement in production of war equipment.



CUT POWER LOSSES with . . .

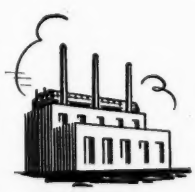
. . . ALDRICH-GROFF CONTROLLABLE CAPACITY "POWR-SAVR" PUMPS

Aldrich-Groff pumps on unit feed systems eliminate pressure and power losses common to throttling-type feed regulating valves and offer advantages of feed system simplicity, efficiency and mechanical reliability for small and medium installations at medium and high steam pressures.

Equally important overall power savings are effected by Aldrich-Groff pumps on de-superheater feed service in connection with high pressure topping units for power stations of any size.

The three Aldrich-Groff 3¼" x 0 to 6" variable stroke vertical triplex pumps shown above are in service in a mid-western central station employing the unit system for main boiler feed. Two are driven by constant speed motors and the third by a constant speed steam turbine. Power consumption is almost directly proportional to pump delivery.

The 6" stroke — 3¼" plunger pump is a 100 HP unit and when operating at maximum speed can deliver 70,000 pounds of feed water per hour against 1025 pounds boiler pressure.



WRITE TODAY . . .

for bulletins and material giving full details, sizes and ratings of Aldrich-Groff Pumps.

THE ALDRICH PUMP CO. ALLENTOWN • PENNA.

Representatives: **Birmingham • Bolivar, N. Y. • Boston • Chicago • Cincinnati • Cleveland • Denver • Detroit Duluth • Houston • Los Angeles • Pittsburgh • Portland, Ore. • St. Louis • San Francisco • Seattle • Tulsa**

GOT A WATER SCALE PROBLEM?

Solve it with SOL-VET "08"

SOL-VET "08" is a fast, efficient cleaner of scale, rust, slime, dirt, algae for all equipment using water for cooling. By dissolving impurities completely, they are carried out *in solution*, thus preventing clogging. Head pressures fall to normal; heat transfer is raised to maximum; full circulation is restored; life of equipment prolonged. On large jobs, shutdown time is cut to a maximum of 6 to 8 hours.

GUARANTEED EFFECTIVE

If you find SOL-VET "08" is not exactly as represented, when used according to instructions and full, accurate report is given within 30 days from date of purchase, your money will be refunded in full.

GUARANTEED HARMLESS

when used as directed, to all water conducting materials used in water cooled equipment.

MAIL COUPON NOW

for complete data, and analysis and recommendations for your specific problem. No obligation, of course.

FILL IN AND MAIL COUPON
—you're not obligated

ANDERSON-STOLZ CORPORATION
1733 WALNUT ST. KANSAS CITY, MO.

☐ Please send complete data on SOL-VET "08."

☐ We are forwarding water sample and mechanical data—please send analysis and recommendations.

NAME_____

FIRM_____

ADDRESS_____

CITY & STATE_____

SOL-VET "08"
Water Treatment Formula
Manufactured and Guaranteed by
ANDERSON-STOLZ CORP.
1733 WALNUT STREET
KANSAS CITY, MISSOURI

In Cooperation With

THE POST OFFICE

. . . we will appreciate it if you will add our new zone number (4) to all mail addressed to us, as shown below:

POWER PLANT ENGINEERING
53 W. Jackson Blvd. Chicago 4, Illinois

As you know, the new Post Office zone delivery system has been adopted to expedite the delivery of mail. Simple in operation, its success depends on the cooperation of all mailers.

The Briggs Clarifier Co. has reorganized its sales force into two divisions, one for automotive distribution and the other for industrial distribution. Henry T. Moore has been appointed General Sales Manager, and E. K. Burgess and J. H. Nash have been appointed Assistant Sales Managers for the Automotive Division and Industrial Division, respectively. Briggs Clarifier also announces the appointment of J. M. Willis as Ohio state sales and engineering representative. He has been with the company since June, 1942, and will maintain headquarters in Springfield. J. J. Stroud has been appointed engineering and sales representative for the state of Kentucky. Mr. Stroud has been with the company since August, 1942, and will maintain headquarters in Paducah.

Announcement is made by Mr. W. C. Carter, president, that Link-Belt Co. has purchased the manufacturing plant and inventory of Link Belt Supply Co. in Minneapolis, and that Mr. Ray S. Wood has been appointed plant manager. Link Belt Supply Co. had worked very closely with Link-Belt Co. since around 1900, having in all this time served as an authorized distributor of Link-Belt Co. products in Minneapolis, St. Paul, and the adjacent territory. The entire Minneapolis organization will be retained, present manufacturing facilities will be improved, and stocks are to be expanded as rapidly as possible. Mr. Wood, the new plant manager, started his Link-Belt Co. career in 1914, in the engineering department at the company's plant in Philadelphia. He received his early engineering training at Drexel Institute, Philadelphia, and since 1925 has been district manager of the Link-Belt positive drive division, with headquarters in Detroit.

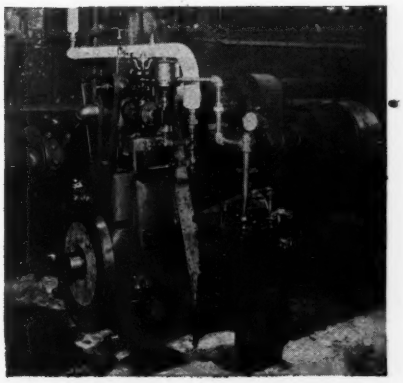
J. B. Trotman, General Sales Manager of the Blackmer Pump Co., Grand Rapids 9, Mich., has announced the opening of the company's new office in the Commercial Trust Bldg., 15th and Market Streets, Philadelphia, Pa. This office will be in charge of B. Dunkley, an engineer of long experience in the pump field. The area served by the Philadelphia office will include eastern Pennsylvania, Southern New Jersey and a part of Delaware.

Allis-Chalmers Mfg. Co. announces the appointment of the Eastern Equipment Co. of Willow Grove, Pa., to handle their complete line of welding equipment. Eastern Pennsylvania, Southern New Jersey, Maryland, Delaware and Washington, D. C., are included in the territory served by this dealer organization.

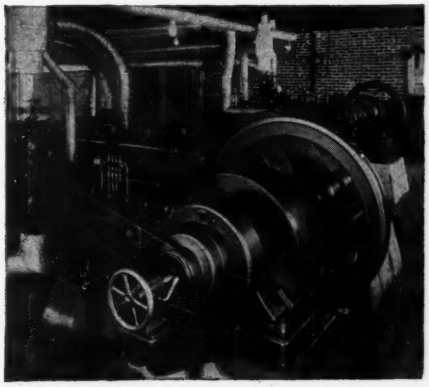
Link-Belt Co. has announced the following promotions: Edward J. Burnell, heretofore vice-president and general manager in charge of Pershing Road plant operations and central division sales, will be vice-president in charge of sales for the entire Link-Belt Co. Harold L. Hoefman, manager of the company's Atlanta plant, succeeds Mr. Burnell as general manager of the Link-Belt Pershing Road plant in Chicago. Richard B. Holmes, district manager at Indianapolis, has been appointed manager of the Atlanta plant to succeed Mr. Hoefman. David E. Davidson, district engineer at the company's Detroit office, has been named district manager at Indianapolis, to succeed Mr. Holmes.

TROY-ENGBERG STEAM ENGINE gives DEPENDABLE *POWER*

Twenty-four hours a day . . . the Troy-Engberg Steam Engine, vertical or horizontal, gives dependable service. Long ago it proved its worth.



It is the ideal power for driving stokers, pumps, blowers, fans, compressors and generators . . . with plus values that include high starting torque and heavy overload capacity; non-sparking construction; wide flexibility in speed range.

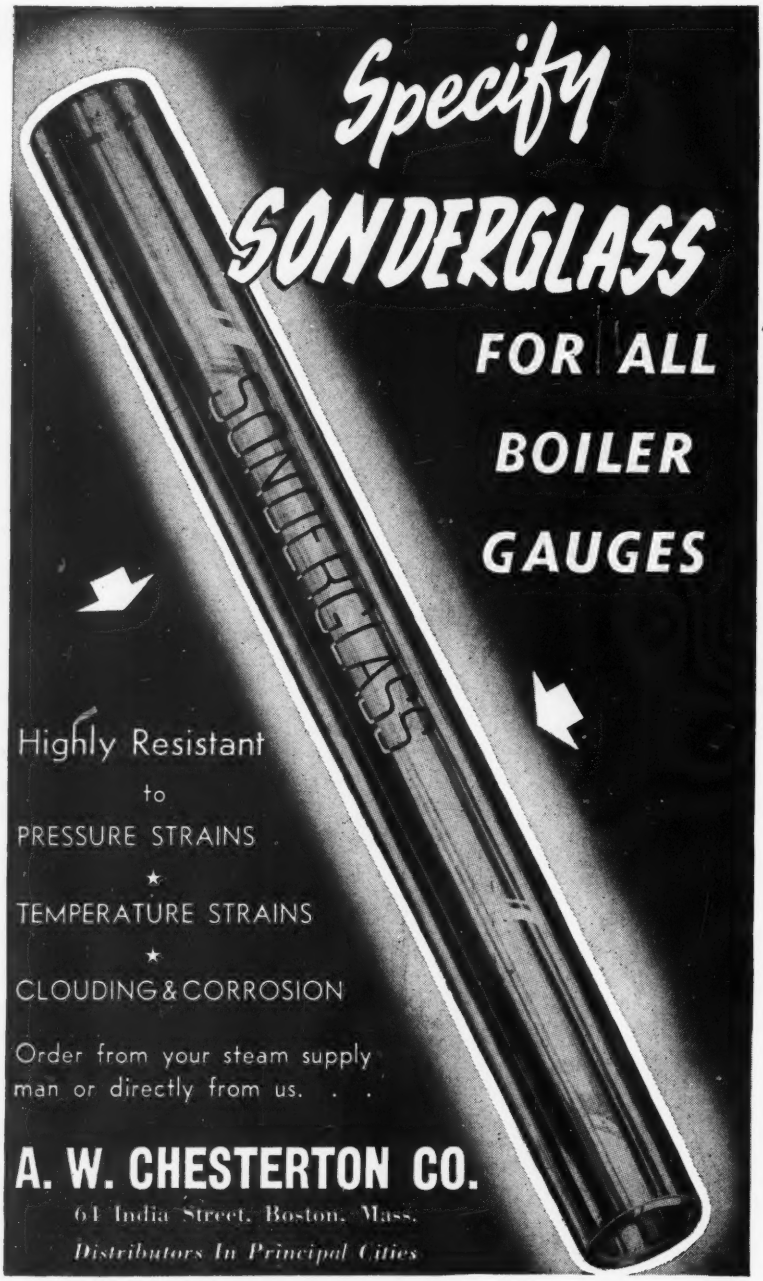


The dependability of the Troy-Engberg Steam Engine has never been surpassed by any drive—in low cost of power when plant heat balances are right — or in low cost of maintenance. Its flexibility is reflected in its controllable wide speed range.

TROY ENGINE & MACHINE CO.

858 RAILROAD AVENUE, TROY, PENNSYLVANIA

12-TEM-3



WHEN YOU WRITE TO ADVERTISERS

When writing advertisers for catalogs, descriptive bulletins or prices, please remember to say, "I saw your message in POWER PLANT ENGINEERING." Thus you'll do a good turn for the advertiser and for this publication. . . .

The Harry W. Parsons Engineering Co. of San Francisco, Cal., has recently been authorized to represent Heat Transfer Products, Inc., 90 West Street, New York City, in the sale and service of the complete line of surface condensers, evaporators, heat exchangers, steam jet air ejectors and allied equipment.

NEWS FROM THE FIELD

Pipe Line to Cost About $50,000,000

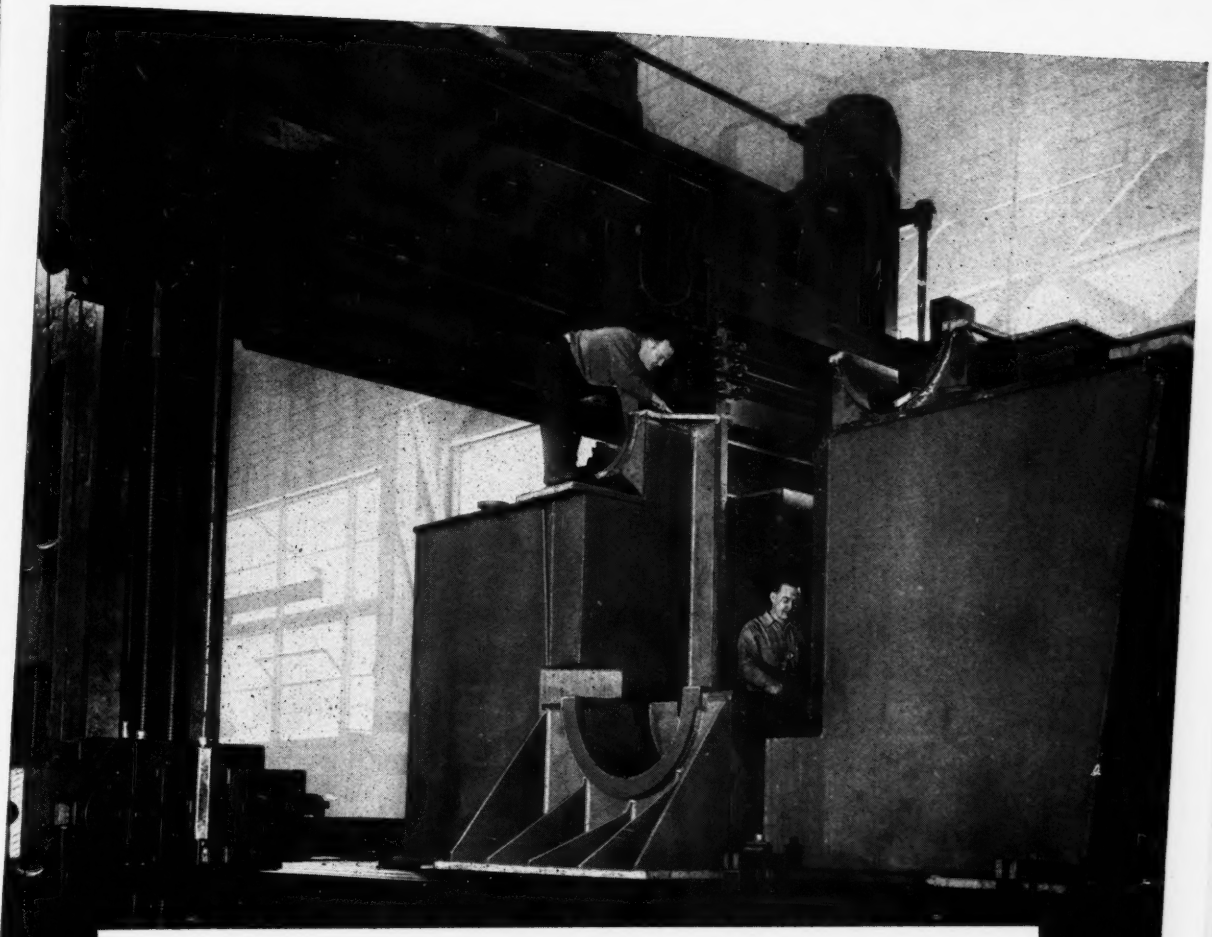
TENNESSEE GAS & TRANSMISSION Co., Chattanooga Bank Bldg., Chattanooga, Tenn., is awarding contracts for equipment for proposed new welded steel pipe line from point near Corpus Christie, Tex., to Cornwall, W. Va., about 1190 miles, for natural gas transmission. Line will be formed of 24-in. pipe, which will be furnished by A. O. Smith Corp., Milwaukee, Wis., and National Tube Co., Pittsburgh, Pa. It is proposed to construct a series of seven compressor stations for booster service at points along route, as well as a dehydration plant, for which construction contract has been awarded to Stearns-Roger Mfg. Co., Denver, Colo. The compressor plants will have a gross capacity of 58,000-hp, consisting of 58 1000-hp units; 27 of these will be furnished by Worthington Pump & Machinery Corp., Harrison, N. J., and 31 by Cooper-Bessemer Co., Mount Vernon, Ohio. Work on these plants is scheduled to begin at early date. Contract for laying of pipe has not as yet been awarded. Authority to carry out project was granted recently by Federal Power Commission, Washington, D. C., and a priority rating has been secured. Entire project is estimated to cost approximately $50,000,000.

New Hydroelectric Station on French Broad River

FRENCH BROAD ELECTRIC MEMBERSHIP CORP., Marshall, N. C., has plans maturing for new hydroelectric generating plant on French Broad River, Madison County, N. C. Bids are scheduled to be asked at early date for general construction of plant, and it is understood that awards have been made for hydraulic turbine, generator and governor. Capacity of station or estimated cost have not been announced. Project is being financed through Federal aid, and will include a transmission line for connection with cooperative electric system, also power substation and other operating facilities. Program will have a priority rating. J. B. McCrary Engineering Corp., 22 Marietta St. Bldg., Atlanta, Ga., is consulting engineer.

Niagara-Hudson Power to Build Lines Costing $1,000,000

NIAGARA-HUDSON POWER CORP., Electric Bldg., Buffalo, N. Y., is arranging an appropriation of about $1,000,000 for construction of rural lines in districts served by companies comprising the system, including Buffalo, Niagara & Eastern Power Co., Buffalo; Niagara Falls Power Co., Niagara Falls; Lockport & Newfane Power & Water Supply Co., Newfane; and Niagara, Lockport & On-

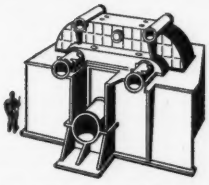


"Barber Chair" FOR A 21-TON GEAR CASE

Here's probably the biggest "barber chair" you've ever seen! And its current customer is a 21-ton gear reduction case for the new 8,500 h.p. Hendy steam turbine units being "shaved" in meticulous thousandths of an inch.

This "chair" is known as a planer and its load capacity of 75 tons on a 510 sq. ft. bed shows the tremendous size of the jobs that Hendy is equipped to handle.

However, this planer is only one unit in the vast array of major equipment that is helping Hendy and its divisions set unprecedented records for turning out massive power equipment with straight-line production methods.



For the Maritime Commission and the Navy Department Hendy production includes steam turbines and reduction gear units up to 8,500 h.p., Liberty and Frigate steam engines, turbo-lighting sets, naval ordnance, hydraulic pumps, motors and generators.

JOSHUA HENDY IRON WORKS

ESTABLISHED 1856

SUNNYVALE · CALIFORNIA

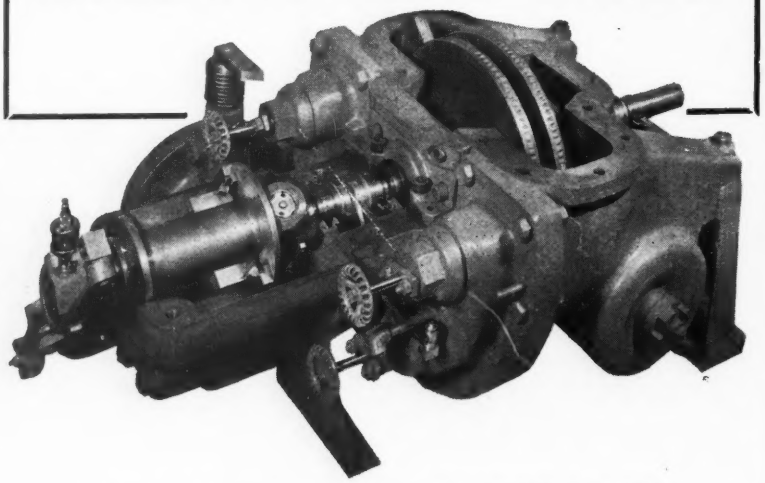
Divisions: POMONA PUMP COMPANY
CROCKER-WHEELER ELECTRIC MFG. CO.

Manufacturing Plants: SUNNYVALE, LONG BEACH, POMONA and TORRANCE in CALIFORNIA • AMPERE, N. J. • ST. LOUIS, MO.
Branch Offices: NEW YORK • WASHINGTON • PHILADELPHIA PITTSBURGH • CHICAGO • ST. LOUIS • SAN FRANCISCO • LOS ANGELES

MURRAY

Type "U"

Mechanical Drive Turbines



★ Many of the advantages of the Murray Type "U" Mechanical Drive Turbine are illustrated in the accompanying internal view. The most outstanding feature is the arrangement of the casing, which as shown, is split horizontally well above the shaft center line. This unique and patented construction provides the following desirable features:

(1) Longer steam ring allowing considerably more nozzle area and larger steam inlet size, thereby increasing the maximum horsepower developed by a particular frame.

(2) Larger exhaust opening which permits of greater horsepower and improved efficiency, particularly for condensing operation.

(3) Additional hand valves for nozzle control. (Note that view shows three hand valves on our smallest frame, whereas the usual small conventional turbine has room for only one.)

Write for Descriptive Bulletin

MURRAY
IRON WORKS COMPANY
INCORPORATED 1870
BURLINGTON IOWA

CLASSIFIED ADVERTISING

POSITION WANTED

Mechanical Engineer—Extensive experience industrial plant work especially Power Engineering, available now for permanent position. Address Box 1431, Power Plant Engineering, 53 W. Jackson Blvd., Chicago, Ill.

Wanted position as power plant operator in middle west. Am experienced, married and employed at present. Address Box 1429, Power Plant Engineering, 53 W. Jackson Blvd., Chicago 4, Ill.

EQUIPMENT WANTED

MOTOR WANTED

One 750 to 1000 KW synchronous motor, 3 phase, 60 cycle, 2300 volts, 240 R.P.M.

The Shartle Brothers Machine Co.
Middletown, Ohio

tario Power Co., Lockport and Buffalo. It is said that project will approximate 900 miles of primary and secondary lines, with installation to include power substation units, line transformers, service connections and other operating facilities. Construction will be carried out in a farm area held essential for food production by WPB, and program is expected to secure a priority rating.

Simplified Safety Valves

RECOMMENDATIONS FOR SIMPLIFIED PRACTICE in the design and manufacture of bronze pop safety and bronze, iron and steel relief valves have been submitted to producers, distributors, users, and others interested for approval or comment, according to an announcement by the Division of Simplified Practice, National Bureau of Standards. The safety and relief valves covered by this program are intended primarily for industrial service and for marine service where applicable. Typical uses are on boilers, unfired pressure vessels, pipe lines and auxiliary equipment.

The development of this recommendation was undertaken at the request of the Shipbuilding Division of the War Production Board in cooperation with the Segment Committee of the Valve and Fittings Industry Advisory Committee. The need for it was made apparent when an analysis of the requirements of claimant agencies for these valves disclosed that all the needs of these agencies could only be met by reducing the variety which the industry was being called upon to make.

The simplified list will satisfy 95 per cent of the requirements for these valves, and considering models, inlet sizes, outlet sizes, connections, will result in a substantial reduction in variety.

Mimeographed copies of the proposed simplified practice recommendation may be obtained upon request to the Division of Simplified Practice, National Bureau of Standards, Washington 25, D. C.

Products Line Pumps

THE WAR EMERGENCY PIPE-LINE project known as the 20 in. Products Line will parallel the 24 in. line, popularly known as the "Big Inch." The Products Line will carry finished refinery products, such as gasoline and fuel oil, whereas the "Big Inch" will normally carry crude oil. Ingersoll-Rand Co. is supplying 41 pumps for the Products Line which were especially designed for this particular job. These are single-stage, centrifugal units. Since it was specified that no critical materials should be embodied in the pumps, all major castings are of high-grade cast iron.

Each pump is driven by a 3570-rpm, 1500-hp electric motor and operates against a total head of 825 ft. Three such machines in each pumping station will operate in series to produce a final line pressure of 8000 psi. This pressure is gradually reduced by friction between stations until the suction pressure at the succeeding station is about 30 psi. The first pump in the series of three builds this pressure up to 287 psi; the second one to 544 psi; and the third one to the final pressure of 800 psi. Capacity of the line will be 235,000 bbl per day, which is 6855 gpm.

The pumps, one of which is shown on test in the illustration, are so designed that two may operate in series or one may operate alone if such an arrangement is desired. With two pumps operating in series, the line will deliver about 83 per cent of its rated capacity, and

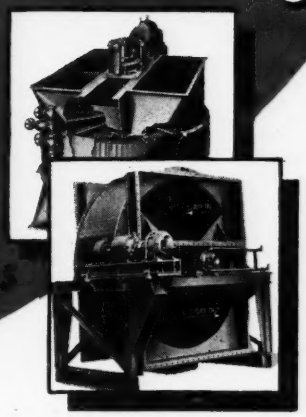
OIL INDUSTRY STEPS UP PRODUCTION OF 100-OCTANE AVIATION GAS

Washington, D. C.—Sept. 20—Production of aviation gasoline to meet the increasing pace of air warfare in both the European and Pacific areas

Behind headlines like this... "Ljungstroms" do double duty

1.. on refinery boiler plants

2.. on cracking still furnaces



Efficiency and fuel conservation in the production of 100-octane gasoline is being aided by use of Ljungstrom Air Preheaters at two critical points in refinery operation.

At one important new plant, four Preheaters are being included as a part of the steam generating plant. Here, they will raise the efficiency of steam generation, and permit efficient combustion of low-grade fuels.

Four other "Ljungstroms" will serve on cracking still furnaces. Gases from the furnace will enter the Preheaters at 1450° F., and preheat the combustion air to over 1000° F. Their ability to handle these high-temperature gases makes possible an efficient furnace design using *less steel* in convection tube banks.

Further conservation of steel is secured in the Preheaters themselves, because of their unique *continuous regenerative counterflow* principle. Generally, a Ljungstrom weighs only ½ to ⅓ as much as alternate types for the same heat recovery, with additional savings in the supporting structure.

Repeat purchases by oil companies having over five years service experience with Ljungstrom Air Preheaters testifies as to the mechanical dependability of these units.

Our engineers are ready to work with you in applying the Ljungstrom to your own heat recovery problem.

For PRODUCTION ACHIEVEMENT...

The U. S. Maritime Commission has awarded its "M" Pennant and Victory Fleet Flag to the men and women of Air Preheater Corporation.

THE

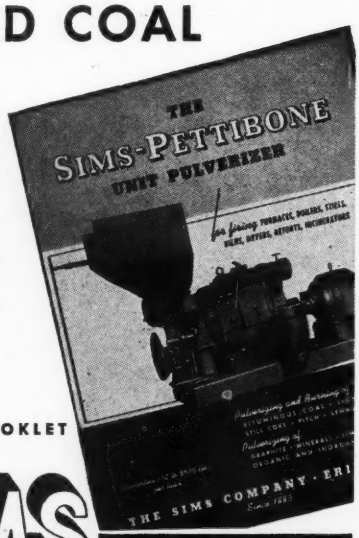
AIR PREHEATER

CORPORATION

Executive Offices: 60 East 42nd Street, New York 17, N. Y. • Plant: Wellsville, New York

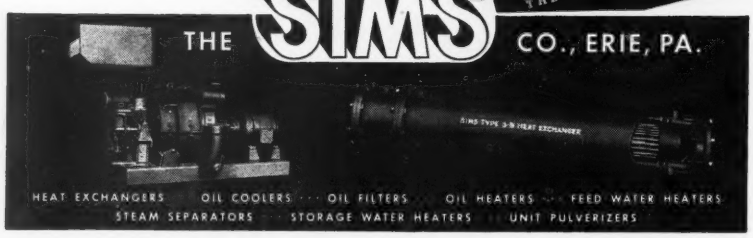
Convert from OIL *to* PULVERIZED COAL

● Keep your oil burner installation and add an **S-P** pulverized coal unit. Oil is vitally needed on the fighting fronts. You will be able to use either fuel and you will discover that coal is as flexible as oil, more economical, and equally dependable. Consult with Sims-Pettibone engineers at once.



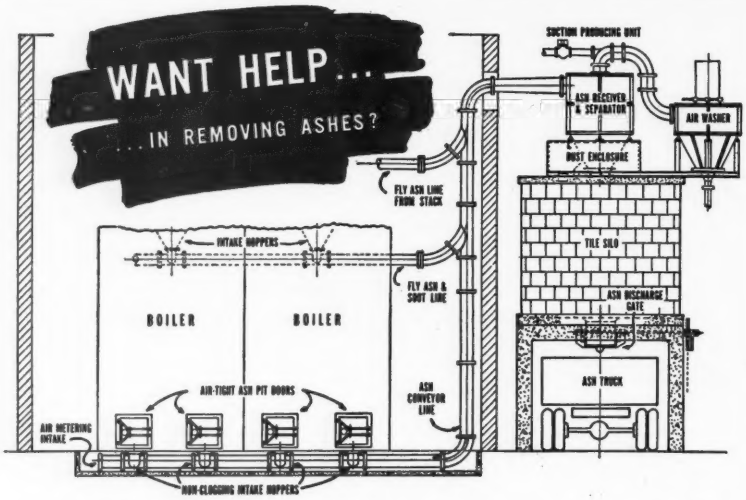
WRITE FOR BOOKLET

THE SIMS CO., ERIE, PA.



HEAT EXCHANGERS · OIL COOLERS · OIL FILTERS · OIL HEATERS · FEED WATER HEATERS
STEAM SEPARATORS · STORAGE WATER HEATERS · UNIT PULVERIZERS

WANT HELP...
...IN REMOVING ASHES?

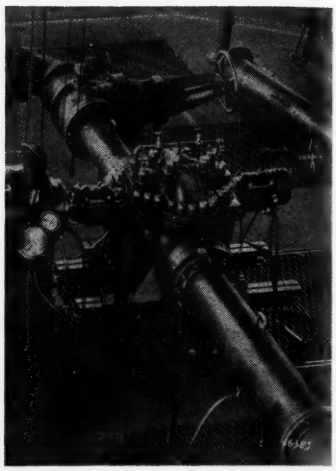


Get the help you need by installing a Beaumont Birch "Vac-Veyor" pneumatic ash handling system. Labor is saved; cleanliness effected. System time-tested. Low first cost. Low operating cost. Installation as flexible as running a pipe line. Minimum critical materials required. Two sizes, two types—for delivering ashes either dry or damp.

For details—write!

BEAUMONT BIRCH COMPANY
1505 RACE STREET PHILADELPHIA, PA.

DESIGNERS • MANUFACTURERS • ERECTORS OF COAL AND ASH HANDLING SYSTEMS



with one pump alone about 55 per cent of rated capacity.

These pumps, Ingersoll-Rand Class 12BHVS, are single-stage, centrifugal units of the horizontally split, volute type. The casing is split on the horizontal centerline. Suction and discharge nozzles and pump feet are part of the lower half-casing. The upper half is easily removed to allow access to the working parts.

The shaft is extra-heavy to provide smooth operation. Within the pump, and through the stuffing boxes, the shaft is entirely covered by the impeller and protecting sleeves. The impeller is of the double-suction, volute type. It is sealed by double impeller rings of the shrouded type.

Bearings are self-aligning, sleeve type. A ball thrust bearing is incorporated in the outboard bearing housing. The bearings are oil-lubricated, and the bearing bodies are arranged for water-cooling. Deep stuffing boxes seal the shaft. They are equipped with a sealing gland and a needle valve connection to the casing. Thus the oil being pumped may be used as sealing liquid in the stuffing boxes.

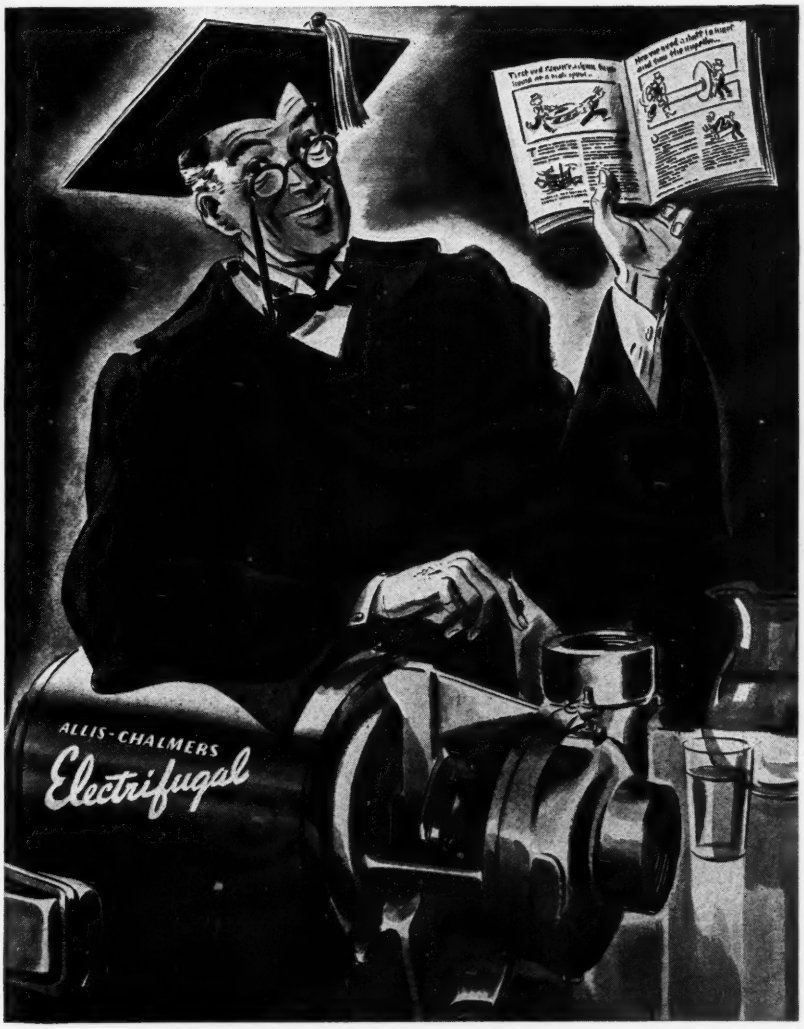
Another Generator in Production at Grand Coulee Dam

THE BUREAU OF RECLAMATION has recently put another generator at Grand Coulee Dam in Washington into commercial production. This addition brings the installed capacity of the plant to more than 700,000 kw, third largest in the United States and fourth largest in the world. The increase in power capacity at Grand Coulee is significant in that it brings the rated capacity of the Bureau of Reclamation's 30 power plants in 11 western states to more than 2,000,000 kw.

Crocker Elected CG&E Corp. President

STUART M. CROCKER was elected president of the Columbia Gas and Electric Corp. at a meeting of the board of directors, November 12, it was announced by Philip G. Gossler, board chairman. Crocker succeeds Edward Reynolds who is retiring to devote full time to his duties as administrative head of the Supply Division, Office of the Surgeon General of the Army, which position he has occupied since November

What's Your Pump I.Q.?



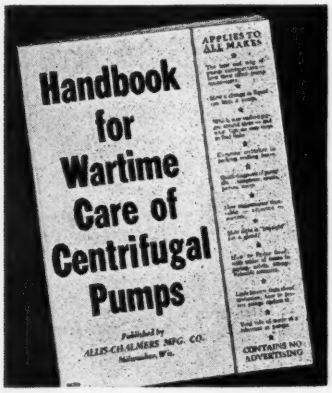
Suggestion — this new book is particularly helpful for training new men to make present pumps last. It applies to all makes — contains no advertising. When you *do* need new pumps, look into the extra efficiency, ruggedness and long life built into Allis-Chalmers centrifugal pumps . . . the famous "Electrifugal" . . . and all types for every purpose.

ALLIS-CHALMERS
MILWAUKEE

WE WORK FOR VICTORY — WE PLAN FOR PEACE

HOW ABOUT A SHORT "REFRESHER" COURSE IN . . . ALIGNMENT PROBLEMS, FIGURING HEAD, PREVENTING CAVITATION, ETC.? SEND FOR ALLIS-CHALMERS' NEW PUMP MAINTENANCE GUIDE!

TODAY, with pumps working harder than ever and replacements more difficult to obtain, you can't afford to take chances on maintenance. That's why Allis-Chalmers has published its new "Handbook for Wartime Care of Centrifugal Pumps".


Handbook for Wartime Care of Centrifugal Pumps
APPLIES TO ALL MAKES
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CONTAINS NO ADVERTISING

In it a pump is built, step by step. As each new part is added we learn what it does, how it does it, how it must be cared for. Tear off coupon below and send for your *free* copy today!

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Milwaukee 1, Wisconsin

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Yes, I would like to receive, *free of charge*, a copy of your "Handbook for Wartime Care of Centrifugal Pumps".

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QUIMBY PUMPS

SCREW
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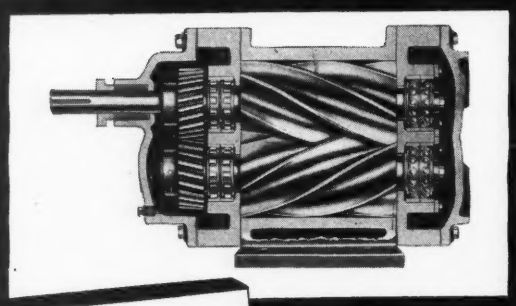

MAINTAIN INITIAL EFFICIENCY
. . . . . throughout their serviceable lifetime.

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of wartime work in lines handling liquids and gases

Don't take chances on costly production shutdowns due to tubing failures. Specify tougher, longer lasting Eclipse *Seamless* Metal Hose for Boiler Tube Cleaners, Diesel Engine Outlets, Steam, Lubricating Oil and other hard-used gas and liquid lines.

The extra flexibility and durability of Eclipse *Seamless* Metal Hose comes from its deep parallel sidewall corrugations. Eclipse *Seamless* Monel hose is stocked in sizes from ⅛ in. to 2 in. I.D.; steel hose up to 40 in. Easily attached fittings for any requirement.

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AIR • STEAM • CHEMICALS
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Manufactured And Sold by

THE INVISIBLE CREW
Precision Equipment by Bendix AVIATION CORPORATION

Dept. 19—Phila. Div.
Philadelphia, Pa.

1942, under leave of absence from the corporation.

Crocker has resigned as vice-president of the General Electric Co. to take over the presidency of the Columbia company.

Crocker was born at Cambridge, Mass., May 26, 1898, graduated from Harvard in 1921, and served with Radio Corp. of America until 1922, when he joined the General Electric Co. as assistant to Owen D. Young, chairman of the board. In 1927 Crocker became vice-president and treasurer of United Electric Securities Co. He was elected vice-president of International General Electric Co. in 1930, and appointed assistant to Charles E. Wilson, then executive vice-president of the parent company in 1938. He was elected vice-president of General Electric in 1940, and since Pearl Harbor, he directed the company's electronic production for the Armed Forces at Syracuse, N. Y.

Turbine Plant Building 1,000,000 hp Yearly

DURING THE YEAR ending in October, the new Westinghouse Merchant Marine plant in Philadelphia, Pa., delivered propulsion machinery for nearly 1,000,000 tons of ocean shipping. This represents an output nearly two and a half times as large as the plant's original promise to the Maritime Commission for performance to this date.

All production from the plant to date has consisted of complete propulsion units. Each such unit is made up of a high and a low pressure steam turbine, and a set of huge speed reducing gears to transmit the power generated by the turbines to the ship's slow-turning propeller.

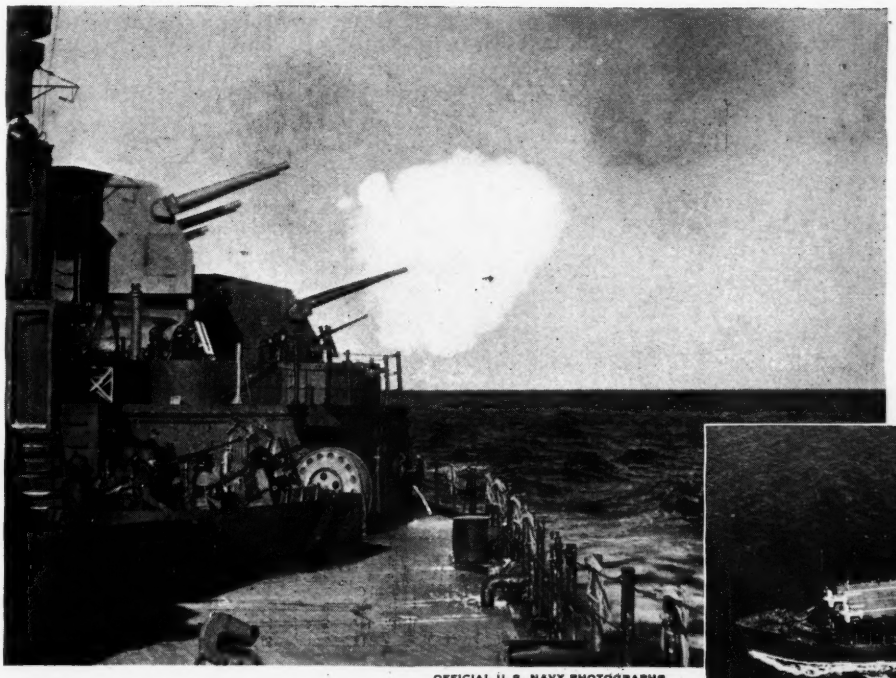
One factor which helped to increase the horsepower output from the huge new plant was the change in Maritime Commission production schedules to put greatly increased emphasis on the building of Victory model cargo ships. This model is a new, fast design with powerful turbine propulsion equipment to enable it to dodge subs and make approximately three times as many ocean crossings a year as the slower, less powerful Liberty ships.

To meet the needs of the Victory ship construction program, the plant is now changing over production facilities to concentrate wholly on the building of the turbines and speed reducing gears for this new vessel. They expect by the end of next year to be producing two and a quarter times as many turbines and five and one-half times as many gears annually as originally promised the Maritime Commission.

This huge expansion of production capacity will be principally the result of "mass production" building methods made possible by concentrating on output of a single type of turbine and gears. Gear production facilities have also been aided by the addition of $2,500,000 of gear-cutting equipment to the original $22,000,000 plant, an expansion of approximately 10 per cent.

When the plant "hits its stride" in production of Victory ship units, Ellis L. Spray, plant manager, predicts it will produce at a rate of nearly 2,000,000 hp of turbines and gears a year, equal to 3,060,000 tons of ships.

The Merchant Marine Division, built with funds supplied by the Defense Plant Corp., is operated by the Westinghouse Electric and Manufacturing Co. for the Maritime Commission.



OFFICIAL U. S. NAVY PHOTOGRAPHS

Seeing Pictures Like These Makes the Headaches Worthwhile

As with most other plants, Busch-Sulzer found it no easy matter to throw its peacetime procedure by the board overnight and get into a full stride of war production. The Navy wanted ammunition hoists above all and quickly. Men, machines and tools had to start from scratch. New men had to be trained. Obstacle after obstacle had to be overcome.

Sooner than we hoped for, the ammunition hoists began leaving our plant. The Navy wanted Diesels and got them, too. The Department awarded Busch-Sulzer its E—and then a star, a second star and now a third.

Now, these official U. S. Navy photographs show what the headaches have helped to accomplish. The 'flat top' is the U. S. S. Long Island, an auxiliary aircraft escort vessel of the type that has been much in the news lately. It is powered by Busch-Sulzer Diesels. The other picture shows the 5"/38s of a battleship being fired. These dual-purpose guns are served by ammunition hoists of the type made by Busch-Sulzer. The hoists are made with watch-like precision. Just what they do for the gun is one of those stories that will astonish you after the war.

Right now it's good to know that skilled American workmen have done and are doing their share to hasten the hour of victory.

BUSCH-SULZER BROS. DIESEL ENGINE COMPANY

SAINT LOUIS

BUSCH-SULZER ST. LOUIS

AMERICA'S OLDEST BUILDER OF DIESEL ENGINES

This Penstock was given a New "Lease of Life!"

Briefly; here's the story

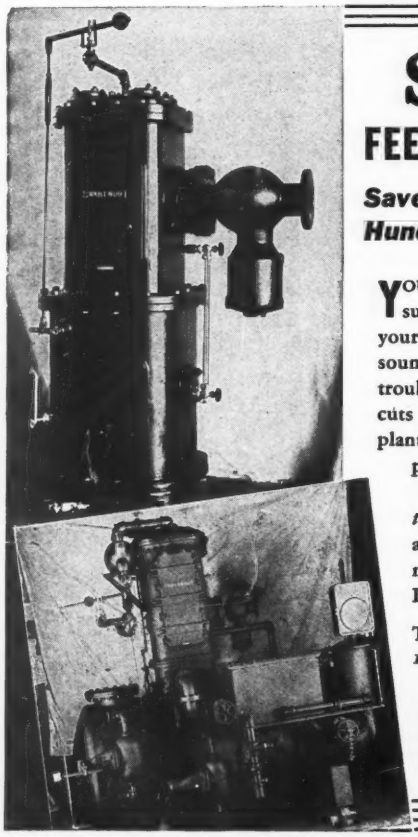
The original steel pipe, 12 feet in diameter had become corroded, pitted and pinholed through the years and was useless. Our engineers were called in to inspect, and reported that it could be reconditioned.

The entire interior was sandblasted to remove corrosion. Then a heavy coating of GUNITE was applied which gave a smooth thick durable lining that will last indefinitely. Time and costs were saved, and years of service added to this Penstock through GUNITE—Sand and Cement applied pneumatically.

Send for Bulletin P for complete details of GUNITE construction work

PRESSURE CONCRETE CO.
ENGINEERS and CONTRACTORS
6 Avenue B, NEWARK, N. J.

GUNITE



Swartwout
FEED WATER HEATERS

Save Trouble and Money for Hundreds of Satisfied Users

YOU can have an adequate continuous supply of oxygen-free hot water for your boilers, assured by Swartwout's sound safe construction and guaranteed trouble-free results. Such performance cuts maintenance costs—keeps your plant running smoothly for vitally important production.

Swartwout Heaters are *engineered to fit your needs*—correct type, size and storage capacity. Your requirements gladly estimated. Write for Bulletins S-18-D and S-193.

THE SWARTWOUT COMPANY
18511 Euclid Avenue, Cleveland, Ohio

Swartwout
Power Plant Equipment

Navy Needs Reserve Officers Qualified for Duty in Ship Repair Units

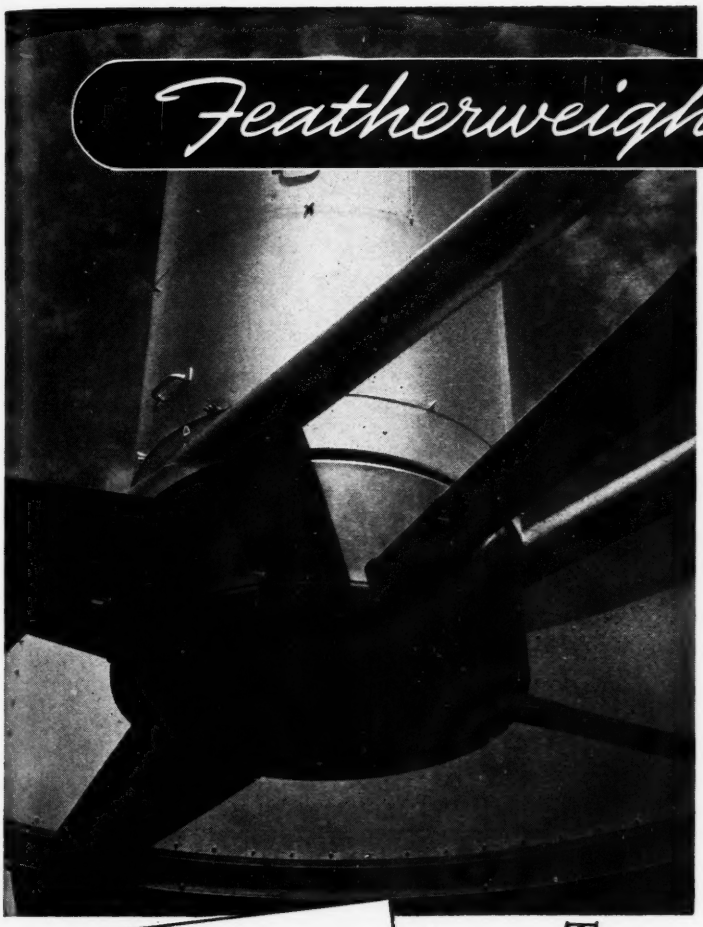
THE NAVY is in need of a substantial number of Reserve Officers qualified for duty in ship repair units for service at advance bases and afloat on repair ships. The work of the officers and men of this branch of naval service has received little publicity but it promises to become a war role no less prominent than that of the Navy's fighting SeaBees. As the Navy comes to closer grips with the enemy it becomes increasingly important that our damaged ships be repaired and returned to battle as quickly as possible. It is for this vital war work that the Ship Repair Units are designed.

In order to qualify for a commission in Ship Repair, civilian applicants should be graduate engineers between the ages of 21 and 42 with practical experience in the construction of steel structures, tanks or boilers or in the production and installation or maintenance of heavy machinery or electrical equipment. Practical experience in the construction, operation, maintenance or repair of power plants and power plant equipment is particularly desirable. Men who have not had formal engineering training but who have had extensive experience in maintenance and repair of Diesel or steam engines or in the operation and maintenance of boilers may qualify as Warrant Machinists for Ship Repair.

The Navy hopes to meet the urgent need for Ship Repair officers partly by commissioning directly from civilian life qualified men who are now or soon will be available for military service or who are not engaged in essential industrial positions. Such men are being urged by the Navy to contact the nearest office of Naval Officer Procurement for further information. A list of district procurement offices appears below: Atlanta 1, Ga., 721-31 Healey Building; Boston 14, Mass., 150 Causeway Street; Chicago 4, Ill., Board of Trade Building, 141 W. Jackson Blvd.; Los Angeles 13, Calif., Title Guarantee & Trust Co. Bldg., 411 W. 5th St.; New Orleans 12, La., Louisiana Building, 217-227 Camp Street; New York 5, N. Y., 33 Pine Street; Philadelphia 7, Penna., 17th Fl. Widener Bldg., Juniper & Chestnut Sts.; Richmond 19, Va., Fifth & Cary Streets; San Francisco 3, Calif., 703 Market Street; Seattle 4, Wash., 117 Marion Street; and Washington 25, D. C., 1320 G Street, N. W.

Proposed Federal Hydroelectric Power Plant in Michigan

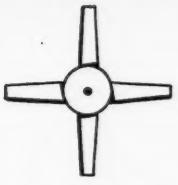
OFFICE OF CHIEF OF ENGINEERS, United States Army, Washington, D. C., is projecting plans for new hydroelectric generating station at Sault Ste. Marie, Mich., at site selected at foot of the rapids. Proposed plant will be equipped for an initial rating of about 14,500-kw, and is estimated to cost approximately $3,500,000. New station would replace existing Federal power plants at same place, now held by Army engineers to be obsolete. One station, located at West end of locks, and operated under lease by Edison Sault Electric Co., is in need



Featherweight Fans

keep operating costs down in

Pritchard Mechanical Draft COOLING TOWERS



COOLING FACTS about PRITCHARD TOWERS

1. Low Pumping Head—uniform water distribution.
2. Maximum water breakup with minimum airflow resistance.
3. Rugged construction — liberal safety factors.
4. Sized and rated for specific job.
5. Greater evaporative cooling effect.
6. Only finest selected Redwood used in all Pritchard towers.

The design of the mechanical equipment used in cooling towers determines the operating cost. The unique Pritchard *Featherweight Fan,* standard equipment in all Pritchard Mechanical Draft Cooling Towers was designed to increase efficiency and thereby reduce operating costs. Made of wrought monel metal, the fan will not corrode or pit. Its airfoil section blades are of the "stressed skin" design and adjustable in pitch. They deliver a uniform flow of air across the entire fan opening. Two to six blades, seven to seventeen feet in diameter, strongly reinforced inside and individually bolted to a monel hub, can deliver up to 400,000 cubic feet per minute.

Pritchard fans reduce operating costs in four ways: (1) Light in weight, they require less power, (2) Corrosion resisting monel metal reduces maintenance costs, (3) Non-pitting, they maintain their high efficiency, (4) Unique design gives maximum air flow.

J. F. PRITCHARD & COMPANY, *Cooling Tower Division,* Fidelity Building, Kansas City, Missouri.

KANSAS CITY
TULSA
CHICAGO

Pritchard

HOUSTON
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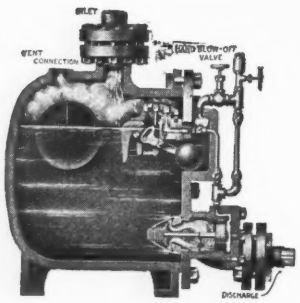
ENGINEERS AND CONSTRUCTORS
FOR THE CHEMICAL • PETROLEUM • GAS AND POWER INDUSTRIES
Manufacturers of Mechanical and Atmospheric Cooling Towers



Piston Operated

A positive, instantaneous, high pressure trap which occupies smaller space yet has greater capacity than any others available. The discharge valve is non-wire-drawing type, being entirely open or closed at all times —orifices of these traps range from 1" to 4" for all pressures up to 650 lbs., as compared with 1/8" to 1/2" used on the average trap. All valves, seats and working parts are of stainless steel for long trouble-free operation . . . for Super-Pressures and Super-Heat in the Super-Power Plant.

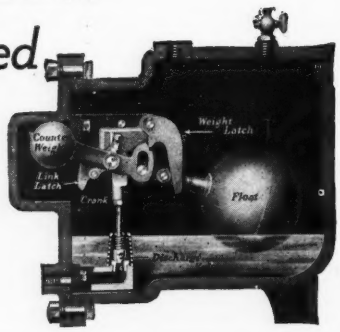
DESIGNED FOR EFFICIENCY ★ BUILT FOR DURABILITY

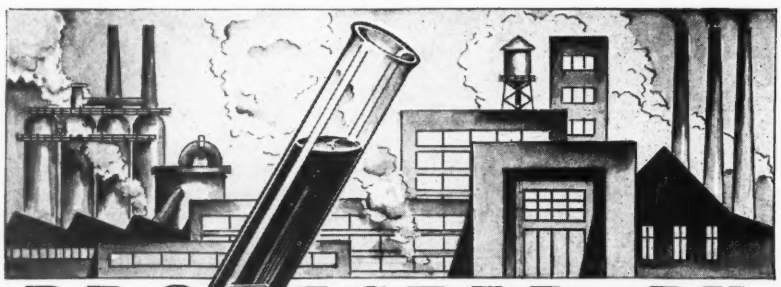
NICHOLSON TRAPS

W. H. NICHOLSON & COMPANY
160 Oregon St., Wilkes-Barre, Pa.

Weight Operated

Positive automatic intermittent action. Large capacity. Pressures to 1500 lbs. at 1000 degree max. temp. Sturdy Design — Dependable Mechanism — not easily affected by dirt, scale, pulsation, vibration, variation in pressure, or other adverse conditions. Quick Opening and Closing Valve—no wire-drawing. Water-Sealed Discharge — impossible for steam, air or gas to escape.





PROTECTED BY HAERING GLUCOSATES

Protect your plant against corrosion, the destroyer of piping systems, boilers and condensers. Corrosion scale retards heat transfer and lowers efficiency. Call in a Haering engineer without obligation, and let him show you how Haering Glucosates save you money and increase production. Or write for these booklets . . .

"Organic Methods of Scale and Corrosion Control"
"Water Studies"
"Water Treating"

WE READ WATER

D. W. HAERING & CO., Inc.
GENERAL OFFICES
205 West Wacker Drive Chicago, Illinois.

of repairs and new equipment, according to report of Engineer Office, with cost of such work estimated at $800,000. The lease extends to June 30, 1944. The other local Federal station is operated under lease by Michigan Northern Power Co., a 30-year period expiring in June 1942; this lease is now being negotiated for a renewal. It is understood that with the construction and operation of the proposed new station, power would be sold to electric companies in this area for local distribution. Proposal to build new plant is now before House Rivers and Harbors Committee, and early decision is anticipated.

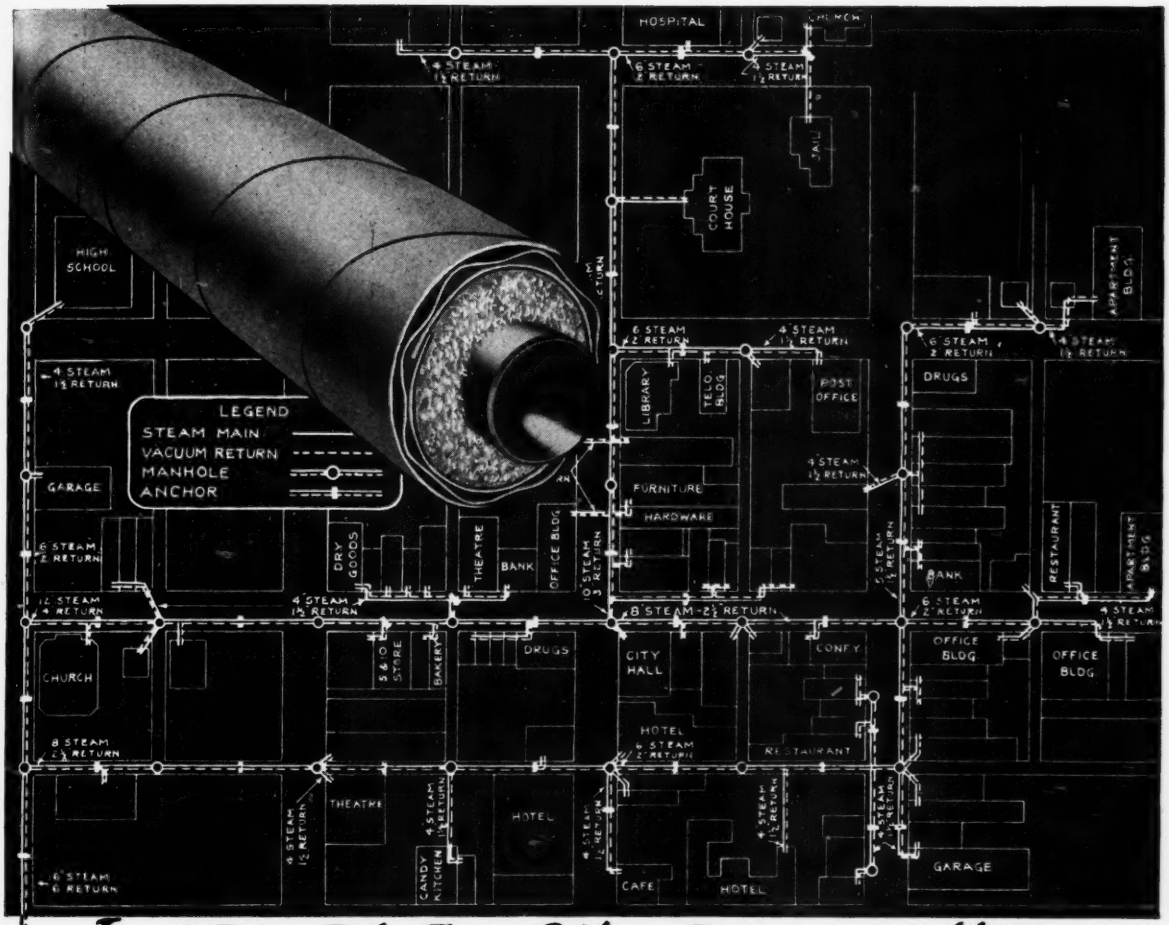
Chile Plant Electrification Program to Cost $100,000,000

THE GOVERNMENT OF CHILE, Santiago, through the Corporation for the Development of Production, a Federal agency, is arranging plans for a large-scale electrification of the country. The program will cover a period of 18 years, with ultimate cost placed at $100,000,000. It provides for the construction of a series of hydroelectric generating stations on principal rivers in Chile extending almost the entire length of the country on the Pacific Ocean, or 2600 miles. The territory will be divided into seven districts from Arica southward; the last two districts, including the area from Puerto Aysen to Straits of Magellan, have not as yet been surveyed or investigated for purpose of hydroelectric power development. In the other five districts, for which plans are being formulated, proposed stations will have a gross capacity of about 6,000,000-kw, with work to be carried out in three periods of six years each. The power supply is required for the development of the economic resources of the country, and project will include a series of transmission lines, with interconnection where feasible between the different generating plants; also power substations and switching stations in various areas, and other operating facilities for power supply. An investigation is in progress for required equipment and it is said that practically all of this will be purchased in United States. Financing for project will be provided in part by Corporation for Development of Production, noted. The initial appropriation is estimated at 500,000,000 Chilean pesos ($20.000,000 U.S. currency), of which 450,000,000 pesos will be underwritten by the corporation. For the period up to 1957, it is estimated that 2,400,000,000 Chilean pesos ($96,000,000 U.S. currency), will be required to carry out the program.

Ash Fusion Temperatures Investigated

RESULTS OF A cooperative investigation undertaken in 16 laboratories to ascertain the effect of various furnaces and atmospheres on the fusibility of coal ash —the tendency of ash to melt at high temperatures—are described in a publication just released by the Bureau of Mines.

Acting at the suggestion of the American Society for Testing Materials, the Bureau prepared ash samples from nine American coals and sent them to each of the participating laboratories. Furnaces using natural gas gave slightly higher fusion temperatures on the average than those using manufactured gas, the laboratories reported. Electric furnaces in which an atmosphere of definite composition was maintained gave somewhat



Ideal Plan For Post-War Community Heating

A CENTRAL HEATING PLANT + RIC-WIL CONDUIT

Outstanding among the advantages of community planning are the benefits gained from central heating—making it possible to purchase *heat* as a commodity like gas, electricity or city water. Ric-wiL Prefabricated Insulated Pipe Conduit provides the most easily installed, dependable, economical and efficient system of heat distribution—proven by more than a thousand miles of all types now in service.

ADVANTAGES OF CENTRAL HEATING WITH RIC-WIL PREFABRICATED CONDUIT

CONSTRUCTION ADVANTAGES:

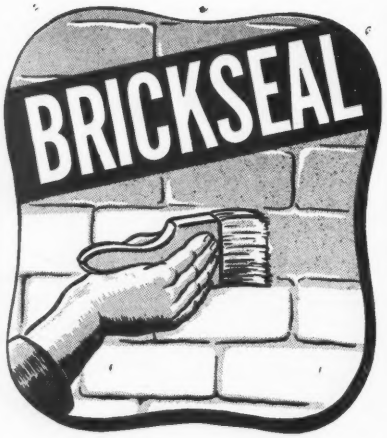
- Conduit furnished complete with prefabricated field accessories.
- Prefabrication minimizes field work.
- Conduit is accommodated in narrow, shallow trench.
- Minimum excavation and backfill.
- Little or no interference with other construction.
- 21-ft. lengths for speedy installation.
- All-weld construction provides durable, watertight system.
- System is efficient, dependable, maintenance-free.

SERVICE ADVANTAGES:

- Savings of 15% or better in overall fuel consumption.
- Elimination of furnace or boiler tending by consumer.
- Promotes cleanliness in buildings heated.
- Provides extra room in building basements.
- Decreases fire and explosion hazard.
- Reduces smoke and soot, provides cleaner, healthier community.
- Eliminates private coal delivery and ash removal.
- Gives uniform, clean heat quickly, whenever needed.

Write for detailed information on Ric-wiL Conduit for central heat distribution.

RIC-WIL INSULATED PIPE CONDUIT SYSTEMS
THE RIC-WIL COMPANY · CLEVELAND, OHIO
AGENTS IN PRINCIPAL CITIES



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Vitrified Armor
for Your
Furnace Lining

BRICKSEAL protects boiler refractories against destructive forces which cause cracking, spalling and disintegration. It can be brushed or sprayed on easily, and the boiler put into production immediately.

Furnace heat vitrifies Brickseal permanently into all pores, cracks and joints, and binds the entire wall with a highly glazed, monolithic coating which prevents damage due to slagging, clinkering, corrosive vapors and flame abrasion. Brickseal cannot crack, peel or blister because it remains semi-plastic, and hardens when boiler cools.

Brickseal costs a fraction of a reline job. It reduces upkeep and shutdowns. Glazed surface reflects heat, increases boiler efficiency and steam production. Write for sample or representative, now.

BRICKSEAL
REFRACTORY CO.
1029 CLINTON ST., HOBOKEN, N. J.

lower temperatures than either of the gas-fired furnaces. Ash-softening temperatures obtained in an oxygen-acetylene-fired furnace diverged most from the average value.

Types of laboratory furnaces had little effect on the ash-softening temperature, the greatest variation occurring with the change in the composition of the atmosphere surrounding the ash samples, research workers said.

Restrict Your Christmas Lighting

J. A. KRUG, Director of the Office of War Utilities, has asked the American people to confine Christmas lighting decorations to Christmas trees inside private homes. Mr. Krug asked that street decorations, community Christmas trees, exterior home decorations and interiors and exteriors of commercial establishments dispense with decorations this year insofar as lighting is concerned.

"Government and industry have combined in a nationwide conservation campaign to save critical fuels and materials necessary to produce and consume electricity," he said.

"I am asking the American people to refrain from their Christmas lighting custom as part of that campaign. Electric light bulbs are particularly short at present and strict conservation of them is necessary. Widespread consumption of bulbs during the Christmas season merely will mean a greater scarcity later on.

"Because of the shortness of daylight over most of the country at Christmas time, necessary consumption of electricity is at its peak. Everything we can do to avoid any additional load will mean direct savings of fuel, manpower, transportation and materials."

Mr. Krug said no mandatory order was contemplated because "the American people realize the necessity of this conservation and will do it."

Aluminum-From-Clay Pilot Plant

DEFENSE PLANT CORP. has selected Harleyville, S. C., as the site for the country's first aluminum-from-clay pilot plant. Use of the materials required has been approved by the War Production Board, and construction is already in progress. If successful, this method of producing aluminum will free the United States from present dependence on foreign bauxite. The contractor is Daniel Construction Co., Inc., of Greenville, S. C., and Birmingham, Ala.

Westinghouse Electronic Tube Output Up 1100 Per Cent

REFLECTING the important part electronics is playing in the war, the Westinghouse Lamp Division at Bloomfield, N. J., recently reported its production of electronic tubes is 11 times as great as it was just two years ago.

Total sales of Westinghouse electronic tubes this year will exceed $22,000,000 as compared with $1,873,000 in 1941, according to an estimate by Ralph C. Stuart, division manager. Mr. Stuart made this estimate in a report to the Board of Directors of the Westinghouse Electric and Manufacturing Company, meeting at the Lamp Division's headquarters plant prior to a tour of the factory and laboratories.

with Armstrong
HUMIDIFICATION
plus reduction in static and drying out of materials

AUTHORITIES AGREE that dry air in plants and offices cuts working efficiency to a surprising degree, encourages winter colds, and favors dust and static. Now you can eliminate this source of absenteeism and lowered efficiency simply, quickly and economically by installing Armstrong HUMIDIFICATION. Other advantages: Prevents warpage and checking of wood, shrinkage of paper, spoilage of foods, cracking of leather, weight loss, and other evils of dry air.

Simple, quiet, practical, high capacity; connected to steam lines like a unit heater. As low as $100 for 40,000 cu. ft. capacity. (Includes Humidifier Trap, Fan, Solenoid, Friez Humidistat.) Used in hundreds of leading plants. A real answer to the humidification problem. Explosion-proof air-operated models also available. Write for literature.

ARMSTRONG MACHINE WORKS
810 Maple St., Three Rivers, Mich.

Write for New Bulletin

ARMSTRONG
STEAM TYPE
HUMIDIFIERS

In Practically Every Industry

SKINNER "UNIVERSAL UNAFLOW" STEAM ENGINES

are generating economical, dependable electric power

FURNITURE MANUFACTURER

Well-known furniture manufacturer in Wisconsin. One 2-cylinder vertical "UNIVERSAL UNAFLOW" Steam Engine, with 625-kv.a., 3-ph., 60-cy., 240-v. A-C generator, belted exciter. Steam pressure 140-150 psi., sat.; back pressure 0-5 psi. Installed 1937. Exhaust steam used for building heat, dry kilns and process.

ADVERTISING SPECIALTIES

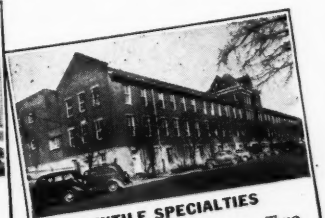
Nationally-known manufacturer of advertising specialties. Two horizontal and one 2-cylinder vertical "UNIVERSAL UNAFLOW" Steam Engines, with 250-v. D-C generators, 1450 kw. total capacity. Installed 1922, '26, '43. Steam pressure 165 psi., 900 F. s. h., 3 psi. back pressure.

MACHINE TOOLS

Well-known machine tool manufacturer in Cincinnati, Ohio. One 4-cylinder vertical "UNIVERSAL UNAFLOW" Steam Engine, driving 600-kw., 3-wire D-C generator and 500-kv.a., 3-ph., 60-cy., 480-v. A-C generator. Steam pressure 155 psi., sat.; back pressure 0-5 psi. Installed 1941.

MEAT PACKER

Prominent meat packer in Indiana. One horizontal "UNIVERSAL UNAFLOW" Steam Engine, with 375-kv.a., 3-ph., 60-cy., 480-v. A-C generator. Steam pressure 175 psi., sat.; back pressure 0-5 psi. Installed 1928. Exhaust steam used for building heat and process.



TEXTILE SPECIALTIES

Large textile plant in Ohio. Two horizontal "UNIVERSAL UNAFLOW" Steam Engines of 450 kw. total capacity, with two 125-v. D-C generators and one belted A-C generator. Steam pressure 120-150 psi., sat.; back pressure 0-3 psi. Installed 1916 and 1937. Exhaust steam used for building heat and process.

MORE than 2,000 power users, in industries and institutions of various types, have found it more economical to generate their own electric power with Skinner "Universal Unaflow" Steam Engines than to purchase power from the local utility.

The outstanding performance of "Universal Unaflow" engines has demonstrated the truth of our claim that they are "the most economical steam engines built." Their high economy is *permanent*—maintained throughout the life of the engine. Scores of installations have been paid for out of savings in fuel, or in comparison with purchased power.

Long life is another inherent quality of Skinner engines. Many of them have been operating twenty-five years or longer. In fact, the first poppet-valve unaflow engine produced in the United States was built by Skinner Engine Company in 1913 and is still in operation.

Although you may have a seemingly low *rate per kilowatt-hour* for purchased power, it will pay you to investigate, for postwar planning, how much lower your *cost* will be for power generated by Skinner "Universal Unaflow" Steam Engines.

Our production facilities, at present, are devoted entirely to building Skinner Unaflow Steam Engines for the war program

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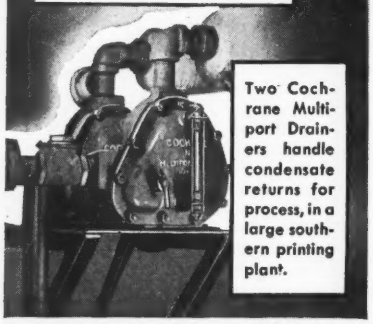
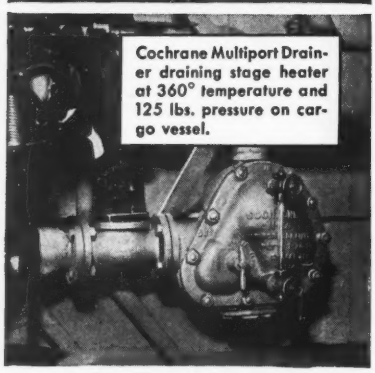
"These traps" (Cochrane Multiport Drainers) "discharge continuously, the valve opening being determined by the height of water in the float chamber; the larger the volume of water, the larger the valve opening. The rotating movement of the sleeve valve serves to keep the valve free of sludge accumulation."

— Steam Engineer of large New England paper mill.



Two Cochrane Multiport Drainers handle condensate returns for process, in a large southern printing plant.



Cochrane Multiport Drainer draining stage heater at 360° temperature and 125 lbs. pressure on cargo vessel.

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Ninety-eight per cent of all electronic tubes being produced by the company are for war use, either in communications equipment or for industrial applications in war plants.

Second Unit Goes into Service at Port Washington

THE SECOND 80,000-KW UNIT, under construction during the past three years at the Port Washington Station of Wisconsin Electric Power Co., was connected to the bus on October 30, 1943 and officially went into operation. This second unit doubles the capacity of Port Washington Station and adds 16 per cent to the generating capacity available on the Wisconsin Electric Power Co. system.

The new installation is fundamentally of the same general design as the first unit. It consists of one tandem-compound 80,000-kw turbo-generator to which steam at 1290 psi gage, 850 F is supplied by a single steam generating unit with a rated maximum capacity of 690,000 lb of steam per hour.

There are three details of design in the new installation, however, that are expected to improve its economy and operating performance over even the high standard set by the first unit. These features are as follows:

1. The generator of the second unit is equipped with a hydrogen cooling system; the first unit was not.

2. Because the condenser circulating water from Lake Michigan is cold enough to permit the condenser to maintain a vacuum of 29.5 in. of mercury (0.5 in. higher than the first unit was designed for) the second unit has longer turbine blades in the last low-pressure stages to take advantage of this higher vacuum.

3. In the second steam generating unit, 2-in. tubes are installed in the rear banks of boiler tubes instead of 3-in. tubes as in the first unit, the object being to reduce the flue gas temperature at the boiler exit.

Another difference in detail is that the second unit is designed to operate at a total steam temperature of 850 F instead of 825 as in the first unit.

In accordance with the original plans made when the first unit went into service in 1935, the present second unit is a complete single-boiler, single-turbine installation, operating entirely independent of the first unit of the plant.

The second steam generating unit, like the first, is a 3-drum bent-tube boiler set with a large, completely water- and steam-cooled dry-bottom furnace, in which radiant superheaters are set in the side walls and a radiant reheater in the rear wall. A convection type superheater is installed between the boiler tube banks and the combination of convection and radiant superheaters maintains a relatively flat steam temperature curve, giving close temperature control over the load range. The unit is fired with pulverized coal from a storage-type coal preparation system. It is equipped with an air preheater but no economizer.

The turbine is of the tandem-compound, condensing, reaction type. After expanding in the high-pressure stages of the turbine, the steam is extracted at approximately 425 psi gage, passed through the reheater in the boiler furnace and returned to the tur-

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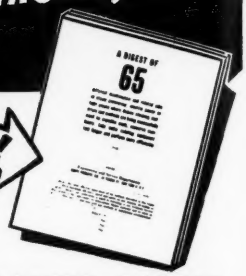

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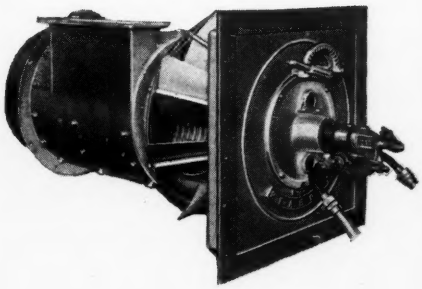

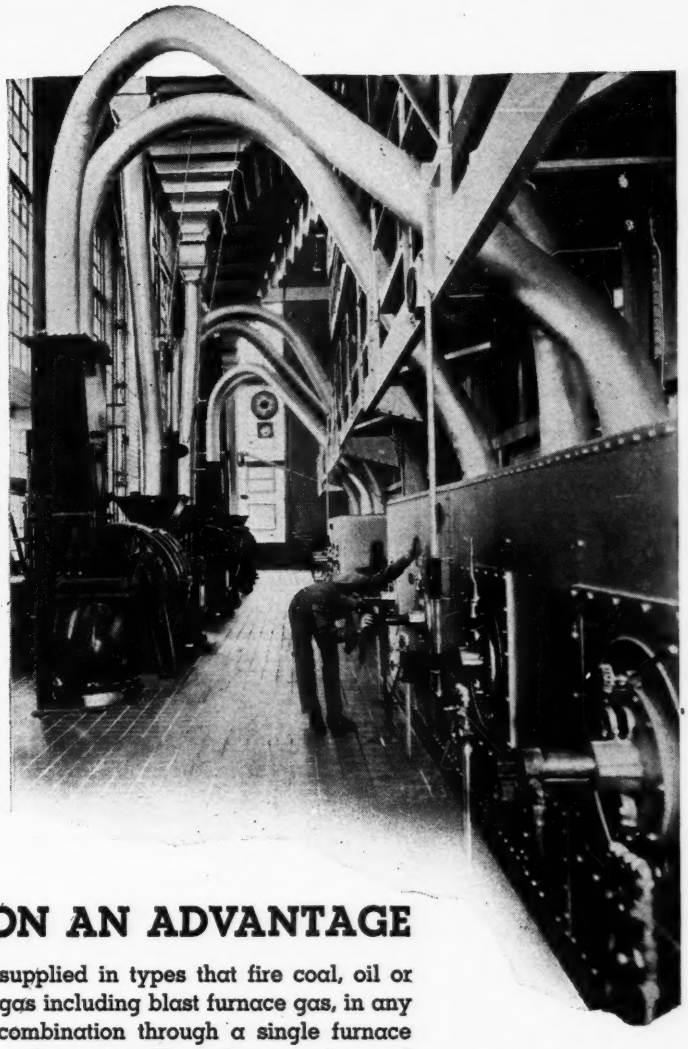

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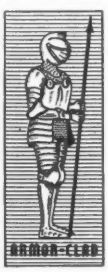

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bine at a temperature of 850 F. The hydrogen-cooled generator is rated at 80,000 kw at 0.85 pf or 94,118 kva. It generates at 22,000 v.

ASRE Meeting to Feature Progress of Refrigeration

AT THE 39TH ANNUAL MEETING of The American Society of Refrigerating Engineers, to be held December 7, 8, and 9 at the Benjamin Franklin Hotel in Philadelphia, technical papers of exceptional value will bring members and interested guests up-to-date on refrigeration progress during the war period, and the Refrigeration Industry Forum, to be held December 9 at the Franklin Institute, is remarkable for its array of industry leaders who will speak. All of these heads and important executives of refrigeration companies as well as Norman Bel Geddes, industrial designer, and B. C. Forbes, business publisher, are engaged in earnest research as to where the industry is going after the war; all of them will share their ideas on this vital subject, and all are agreed that refrigeration has a vast future potential. No engineer or business man engaged in refrigeration and air conditioning can afford to miss this unique forum of keynote men in the industry.

Another important feature of the ASRE convention is a symposium on "Foods of Today and Tomorrow," to be held December 8, at which Prof. D. K. Tressler will serve as moderator. Here leading authorities on quick freezing, dehydration, compressed foods, warehousing and similar fields, will exchange information on the newest techniques.

Federal Power Commission's Annual Report Available

THE FEDERAL POWER COMMISSION has announced the publication, for the sixth consecutive year, of its annual report entitled "Statistics of Electric Utilities in the United States" which presents, for the year ending December 31, 1942, detailed financial and operating information on the 359 major privately owned electric utilities in the country. These utilities, which had total assets on their books aggregating $18,009,963,065 at the end of 1942 represent in excess of 95 per cent of the entire privately owned electric utility industry in the nation on the basis of either assets or revenues. The 1942 edition also contains, for the first time, composite financial statements of the companies for the years 1937 through 1942. These composite statements have been summarized in a 10-page report entitled "The Financial Record of the Electric Utility Industry, 1937-1942." This is a factual statement showing the financial progress of the industry since the institution of uniform accounting and other controls.

Copies of the 10-page report entitled "The Financial Record of the Electric Utility Industry" are available from the Commission free upon request. Copies of the 500-page 1942 edition of "Statistics of Electric Utilities in the United States," which is bound in blue cloth, and may be referred to as "FPC S-30," are not available for free distribution but are sold by the Federal Power Commission at $2.00 a copy. Remittance should ac-

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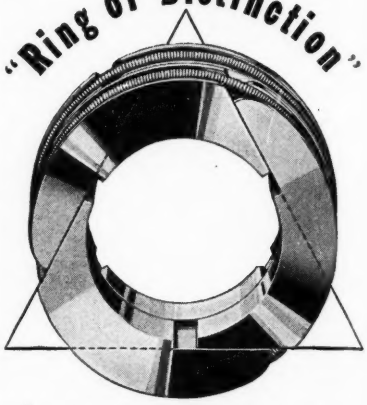

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Now available in sheet-steel housing to avoid critical materials.

Can be supplied with complete indicating system.

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NEW ENGINEERING BOOKS

Radio Material Guide. By Francis E. Almstead and F. R. L. Tuthill. First edition, 242 pages, 5¼ by 7½ in., cloth. McGraw-Hill Book Company, 330 W. 42nd Street, New York. 1943. Price $2.00.

This little book is a text designed especially to familiarize young men who plan to enter the armed forces with the radio theory, tools and equipment needed to prepare for radio work. Condensing the fundamentals into a 16 weeks course, this book presents all the material required to acquaint the student with the equipment and methods of radio work he will use in the Army, Navy or Coast Guard. It gets him ready for actual assignment in any of these branches of the armed forces, and introduces him to the basic concepts he will wish to take along for future review and reference.

Naturally, this book is also of interest and value to others not going into the service. For those practical men in industry who wish to acquaint themselves with the fundamentals of radio and simple electronics, the book has distinct value. The fundamentals are described in a simple and direct manner understandable to those who have not had previous technical experience. The subject matter covered is the standard information on general electricity, simple circuit behavior, and the operation of the essential equipment.

Mathematics Essential to Electricity and Radio. By Nelson M. Cooke and Joseph B. Orleans. First edition. 418 pp, 6¼ by 9½ in., cloth. McGraw-Hill Book Company, Inc., 330 West 42nd St., New York, N. Y. 1943. Price $3.00.

The essentials of algebra, geometry, and trigonometry needed to solve everyday problems in electricity and radio, and the necessary theory and applications of both subjects are presented in this book in simplified form. It offers a review of fundamental processes and then applies these processes to typical problems in electricity and radio. The material is presented in simple and non-technical language. Included is an especially understandable explanation of Ohm's Law and Kirchhoff's Laws. All radio and electrical terms are lucidly explained and completely defined.

The volume is intended to provide students with a sound mathematical background and to further their basic understanding of the basic principles of electricity. The student who has some high-school mathematics will find that the earlier chapters form a comprehensive review and will aid in applying mathematics to radio and electric circuit theory.

The book should be of particular help to the practical engineer in industry who is called upon to apply electronic devices. While the emphasis is on radio and communication, the

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- **Provide cross-flow of gases over tubes for maximum heat-transfer**
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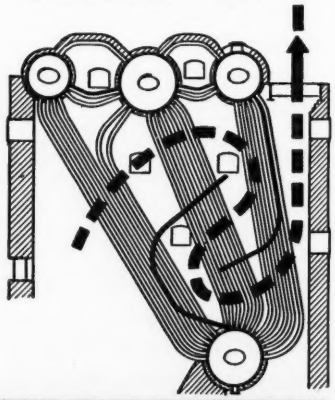

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HELPFUL BULLETINS

Practical answers to many wartime problems of plant operation and maintenance are found in the engineering bulletins offered by manufacturers. For your convenience we publish the following summary of helpful literature available. To obtain copies of the bulletins and catalogs described, simply indicate the paragraph numbers on coupon on next page, detach and mail.

BOILER PLANT EQUIPMENT

1 **Furnace Wall Coating**—New bulletin tells how Armor-Clad monolithic coatings for furnaces prevent flame penetration and slag formation. Adapted to all fuels. Applied with brush or spray gun. Armor-Clad Co.

2 **All Purpose Stoker**—Bulletin No. 500 describes advantages of the Canton De Luxe worm feed stoker for small and medium sized industrial and commercial applications. Features include side ash dumps, extra grate area, zoned air control, dur-alloy steel hopper. Canton Stoker Corp.

3 **Refractory Concrete**—24-pg book features characteristics of Lumnite, methods of making refractory concrete, heat-resistant concrete and refractory-insulating concrete. Book contains many photographs and tables. Atlas Lumnite Cement Co.

4 **Steam Plant Equipment**—Helpful specifications and application data on Yarway boiler blow-off valves, water columns and gages, expansion joints, steam traps, strainers, nozzles and liquid level indicators will be found in new Bulletin G-1306. Contains many sectional drawings and mounting diagrams. Yarnall-Waring Co.

5 **Sectional Hairpin Heat Exchangers**—A 6-pg Bulletin No. 432 covers the newly improved Brown Fintube type BFT-1 "Sectional Hairpin" heat exchangers. Describes the "Non-Removable" rear end assembly introduced in these new exchangers, which is said to permit easy and quick entrance into the exchanger for inspection, cleaning, etc., also the easily assembled "Head Seal"—gives dimensions of standard sizes—performance data, and a detailed explanation of other design and structural features of interest to engineers, works managers, superintendents, etc. The Brown Fintube Co.

6 **Automatic Combustion Controls**—The Hays Corporation has announced two new publications on combustion control. Bulletin 43-605 illustrates applications of automatic control to various types of fuel feeding equipment and explains in detail the principles of combustion control. Bulletin 43-606 illustrates the complete line of Hays controllers and their application in many industries. These publications are informative and should be in the files of every engineer interested in instrumentation of automatic control.

7 **Heavy-Duty Stokers**—20-pg bulletin features Iron Fireman Poweram heavy-duty stokers for boilers developing up to 400 hp; outlines features of these stokers, shows actual installation photographs and lists representative users. Iron Fireman Mfg. Co.

ELECTRICAL EQUIPMENT

8 **Percentage Differential Relays**—How General Electric Type HDD percentage differential relays improve system stability and increase load capacity is discussed in new Bulletin GEA-3572. Outstanding characteristic of these relays is the harmonic-current restraint feature which prevents incorrect tripping on unbalances caused by transformer-magnetizing inrush currents, etc. General Electric Co.

9 **Electrical Maintenance Equipment**—Martindale commutator stones, slot cleaning outfits, insulating varnish, armature testers and many other electrical maintenance items are described in new Catalog No. 24. Contains 48 pg, many illustrations. The Martindale Electric Co.

10 **New Electric Welder for War Production**—Benefits to war industry of the new Ampac "400" a-c welder are outlined in a 4-pg Bulletin B-6302 released by Allis-Chalmers. Comparative advantages of the 400 amp size of welder to the purchasing agent, the welding engineer and the welder himself are told in this bulletin. A pictorial section shows for the first time the step-by-step construction and internal assembly of a continuously variable heavy duty a-c welder. Complete electrical performance data on this unit at all loads are also given.

11 **New Air Circuit Breaker**—A new trip-free air circuit breaker, known as Type KC, with an interrupting rating of 50,000 rms amp, is described in Catalog 1301. Ratings are 600 v a-c, 250 v d-c, 100 to 1600 amp. Operation may be either manual or electric; one, two and three pole styles are offered. Construction features include silver-alloy main contacts brazed to solid-copper contact blocks, auxiliary and arcing contacts which are also made of silver-alloy and magnetic arc chutes with blowout coils and iron vanes. I-T-E Circuit Breaker Co.

12 **Motors and Generators**—Handy file-size folder contains illustrated bulletins on design and performance of Burke a-c and d-c generators, motor generator sets, induction and synchronous type motors and terminal blocks. A useful reference for electrical engineers and operating men. Burke Electric Co.

13 **Electricity in the Chemical Industry**—Electricity in the chemical field is the subject of an attractive new 40-pg bulletin (GEA-3710) recently issued by the General Electric Co. It illustrates and briefly describes G-E equipment used in the chemical industry for generating, transforming and distributing power; for material handling; for processing in the electro-chemical and thermo-chemical fields; and for operation in dusty atmospheres and in hazardous locations. Final section of the bulletin is devoted to illustrations and descriptions of various instruments for electrical measurements.

14 **Warning Signal Lights**—Catalog No. 43 pictures and describes Dialco pilot light assemblies for use in marine, electronic, electrical and industrial applications. Prompt deliveries. Dial Light Co. of America, Inc.

15 **Pressure-Treated Wood**—Uses of pressure-treated lumber in the utility field comprises one section of a new book on preserved wood just issued by Koppers Company, Wood Preserving division, which is offered as a guide in material selection for utility engineers, contractors and maintenance superintendents. Pictured are a number of typical installations in the utility field, including pressure-creosoted transformer stations, and telephone and telegraph lines for over-water and land lines. There also is a reference list of recommended uses of pressure-treated lumber in the utility and other fields.

FANS, PUMPS AND COMPRESSORS

16 **Pump Bulletins**—Complete details on Warren pumps are contained in Bulletins 228 and 229. Dimensional data, capacities, etc., on a complete line of centrifugal, liquor, duplex and single piston, plunger, vacuum, etc., will enable you to find just the pump to fit your particular needs. Warren Steam Pump Co.

17 **Fire Pump Units**—Fairbanks-Morse gasoline engine driven pumps of 500 gpm, 750 gpm and 1000 gpm are described in new Bulletin 5813FS. Includes dimensions and fuel system data. Fairbanks, Morse & Co.

18 **Air Compressors**—Pictured and described in new 16-pg bulletin are Schramm air compressors, portable and stationary. Models are available with flat belt or "V" belt motor drives or engine drives in line. Schramm, Inc.

19 **Boiler Feed Pumps**—Bulletin No. 42-4500 contains interesting sectional views in color of Byron Jackson double case centrifugal boiler feed pumps. Also shows typical installation photos, temperature correction and NPSH charts and other data useful to design and operating engineers. Byron Jackson Co.

20 **Philadelphia's Pumping Units**—Bulletin "De Laval Pumping Units at Philadelphia" traces notable developments in the history of one of America's oldest and largest water systems. In 1801 the City of Philadelphia installed its first engine-driven pumping unit. In 1907, it was one of the first municipalities to use centrifugal pumps for water works service. Bulletin also includes information concerning the effect of wear on pump efficiency, tests made six years after installation having shown no measurable loss in efficiency. De Laval Steam Turbine Co.

INSTRUMENTS AND CONTROLS

21 **Smoke and Combustion Indicators**—Attractive new file holder describes the design and operation of Ess smoke and combustion indicators, electronic or visual. Their measurement of smoke haze and flame color permits control of the fuel-air ratio so that boiler operations are maintained at top efficiency. Electronic type may be fitted with sound alarms and recorders. Ess Instrument Co.

22 **Manometers** — Construction features and application data on Trimount well type, sliding scale and fixed scale manometers, indicating flowmeters, liquid level indicators, etc., are given in new 8-pg bulletin. Includes views of typical installations, list of users. Trimount Instrument Co.

23 **Instrument Mounting Structures**—New general catalog includes a description of Falstrom's many fabricated steel parts and instrument mounting structures such as panel boards, unit panels, cubicles, switchgear cabinets, housings and enclosures. Falstrom Co.

MECHANICAL TRANSMISSION

24 **Belt Length Calculator** — New handy slide rule calculator makes it easy to figure belt length, once you know diameters of large and small pulleys, and center distance. J. E. Rhoads & Sons.

25 **Speed Reducers**—New 8-pg Bulletin No. 643 contains information about Saco speed reducers and how to select proper type and size for conveyors, agitators, blowers, pumps, mixers, hoists and other equipment. Also includes dimensions, horsepowers, speeds, sheave and V-belt data for various reducer units. Stephens-Adamson Mfg. Co.

26 **Wire Rope Conservation**—New bulletin contains helpful pointers on flushing, cleaning, lubricating wire cable so that its working life may be extended as much as 25%. Many sketches of lubricant application methods. The Keystone Lubricating Co.

27 **Quick Detachable Sheaves** — The Worthington "QD" sheave—easy to get on, easy to get off—is described in new 16-pg illustrated bulletin. Contains installation views, dimension tables and data of value to engineers with power drive problems. Worthington Pump and Mach. Corp.

28 **Rubber Products for Industry**—Printing of the Golden Anniversary Edition of "Manhattan Rubber Products for Industry," a 140-pg catalog of industrial rubber goods, has been completed. Engineering data on belting and hose and technical information on other products is included. The Manhattan Rubber Mfg. Division of Raybestos-Manhattan, Inc.

29 **Variable Speed Control Handbook** —A wealth of useful data on the selection and operation of variable speed controls will be found in the new 128-pg Reeves handbook and catalog No. G-435. Contains photos showing typical industrial applications, rules for figuring size and speed of pulleys, rating tables, dimension diagrams, etc. Reeves Pulley Co.

PIPING, VALVES AND FITTINGS

30 **Pipe Tool Catalog**—New 1944 Beaver Catalog tells all about pipe cutters, threaders, reamers and other pipe tool equipment. Includes description of latest portable power units; pipe cutting performance data; shipping weights and prices. Beaver Pipe Tools, Inc.

31 **Pipe and Tube Bending Handbook** —New 84-pg handbook covers practical methods for bending pipe and tubes of copper, brass and related alloys. Contains many illustrations of typical pipe bending operations, tables to determine sizes, weights, bursting pressures, etc. Design and operating engineers will find this a useful reference. Copper & Brass Research Association.

32 **Piston-Ring Expansion Joint**—A new 14-pg 8½x11 in. illustrated Bulletin No. 35-15C on the ADSCO Piston-Ring Type, slip expansion joint, which can be completely unpacked and repacked under full operating pressure, giving details of construction dimensions and list prices in sizes from 1½ in. to 20 in. for steam pressure to 400 lbs has been issued by the American District Steam Co.

33 **New Training Film on Piping Pointers**—Seeing and hearing this sound film will give new, inexperienced maintenance workers a clear understanding of how to handle valves, fittings and piping accessories to keep pipe lines flowing. "Piping Pointers" will be available for showing in any plant, trade school or industrial training center. Send for comprehensive "Piping Pointers" manual. Crane Co.

34 **Handbook for Figuring Pipe Wall Thickness**—New Bulletin 43-A contains handy data tables and typical examples showing how to calculate pipe wall thickness for power piping, gas and air piping, oil pressure piping. This should prove to be a very valuable handbook for every design and operating engineer. Midwest Piping & Supply Co.

35 **Steam Trap Tips**—Catalog 66 explains features of Strong steam traps. Also provides important trap facts, selector chart, steam table, installation tips of value to engineers and maintenance men. Strong, Carlisle & Hammond Co.

36 **Handbook on Flexible Tubing**—A new 36-pg manual (SS-44) on Rex-Flex stainless steel flexible tubing and bellows contains much engineering data and specifications not heretofore published. Characteristics of the product are shown in detail, with tables of sizes, weights, wall thicknesses of the various wall forms, together with pressure data, minimum bending radii and a wealth of other detail useful to the engineer. Complete data on fittings is also given, with diagrams and instructions for attaching fittings, and recommended design procedure for various types of applications. Chicago Metal Hose Corp.

PRIME MOVERS AND EQUIPMENT

37 **The Story of the Turbine**—A 24-pg illustrated "Story of the Turbine" has been released by General Electric Co. The publication, GEB-129, is a summary of the highlights in the development of the steam turbine that today produces most of the nation's electric power and drives many of America's naval and merchant ships. Written primarily for the layman, the booklet includes little technical discussion.

38 **How Diesel Engines Serve Our Combat Forces**—"Cavalcade of Fighting Horsepower," a new 16-pg booklet published by Caterpillar Tractor Co., gives a graphic portrayal of the part Caterpillar tractors and portable power generating units are playing in World War II. Important chores on many fronts, including the Aleutians, Africa, Arctic, New Guinea, Great Britain, Mediterranean and New Caledonia are pictured and described.

39 **Mechanical Drive Turbine**—Bulletin H-14, on Elliott mechanical drive turbines with built-in reduction gearing, is a new 4-pg letter-size publication of the Elliott Co. To avoid the cost of a separate reduction gear coupled to a turbine for driving machines operating at low speed relative to the best operating speeds of steam turbines, Elliott builds mechanical drive turbines with reduction gearing built into and forming an integral part of the drive. The design is suitable for driven machine speeds up to approximately 2000 rpm.

40 **Manual on Plant Accounting and Control**—An instructive 45-pg booklet entitled, "Accounting and Control Manual," has been prepared by The Cooper-Bessemer Corp., engine and compressor builders. Subjects include descriptions of the methods used for controlling engineering design, ordering, recording and storing materials, purchasing, timekeeping and inspection, production, payroll and inventory. A flow chart of standard costs and variances is included as well as a glossary of office, shop and product terms and principal part designations for their Diesel engines, gas engines, and Type GMV compressors.

WATER TREATMENT

41 **Boiler Water Conditioning**—Bulletin 504 covers the "inside story of boiler water conditioning" by explaining the types of impurities found in boiler feedwater, how these impurities accumulate, what happens when subjected to boiler temperatures, the common cause of boiler scale, sludge, corrosion and carryover and how to prevent these troubles. Also describes the Elgin Deconcentrator—a simple, ingenious boiler attachment for clarification of boiler water. Elgin Softener Corp.

42 **Chlorination of Condenser Cooling Water**—Technical Reprint No. 468 presents valuable data on chlorination of circulating cooling water, for the control of slime on the tube surfaces of condensers and other low temperature heat exchangers. Many photos and charts illustrate points in chlorine solution application. Wallace & Tiernan Products, Inc.

43 **Scale and Slime Removal**—New folder describes Sol-vet "08," a recently developed chemical compound for the effective removal of scale, rust, dirt and algae in water-cooled condensers, circulating lines, cooling towers, etc. Said to be harmless to pump, pipe, hose, valves and connections. Anderson-Stolz Corp.

44 **Water Conditioning System**—New bulletin describes the technical water conditioning system which provides individual formulas to fit every water type. Said to provide a special balance of water properties that overcome scale, foaming, pitting, corrosion, caustic embrittlement. Water Treatment Co. of America.

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45 **Handbook on Plexiglas**—New 98-pg handbook contains data on mechanical properties, applications of flexible Plexiglas in aircraft construction, safety shields, controller housings, test models of valves and meters, etc. A useful reference book for design and operating engineers. Rohm & Hass Co.

46 **List of Engineers' Handbooks**—New folder describes contents and prices of Audels guides for engineers and mechanics. These handbooks explain theory and operation of automobile engines, welders, Diesel engines, refrigeration, light and power wiring systems, etc., also aids to engineers' examinations, with q and a. Theo. Audel & Co.

47 **What Makes a Grease**—This booklet points out the various factors which should influence the selection of the proper grease for a specific job. It describes the outstanding characteristics of the various Sun greases that have been developed for different uses . . . including Adhesive Pressure Grease, Gun Grease, Pressure System Grease, Roller Bearing Grease and Mine Lubricants. It cites specific applications of these greases and results obtained. This authoritative little book is "must" reading for any industrial engineer or production man interested in lubrication. Sun Oil Co.

48 **Maintenance Handbook**—New Power Plant Digest covers methods for cleaning and de-scaling heat exchange equipment and cooling systems; boiler-room equipment; salvaging fittings, valves, pumps, line hardware, etc.; stripping paint, varnish from motor housings, armature coils and wires, radiators, transformers, gas meters, etc., prior to inspection, repair, overhaul or repainting. A valuable addition to every engineer's library. Oakite Products, Inc.

49 **Packing Reference Data**—New 44-pg France packing catalog contains useful information on packing designs for various service, installation tips, methods of lubrication; also handy reference tables. The France Packing Co.

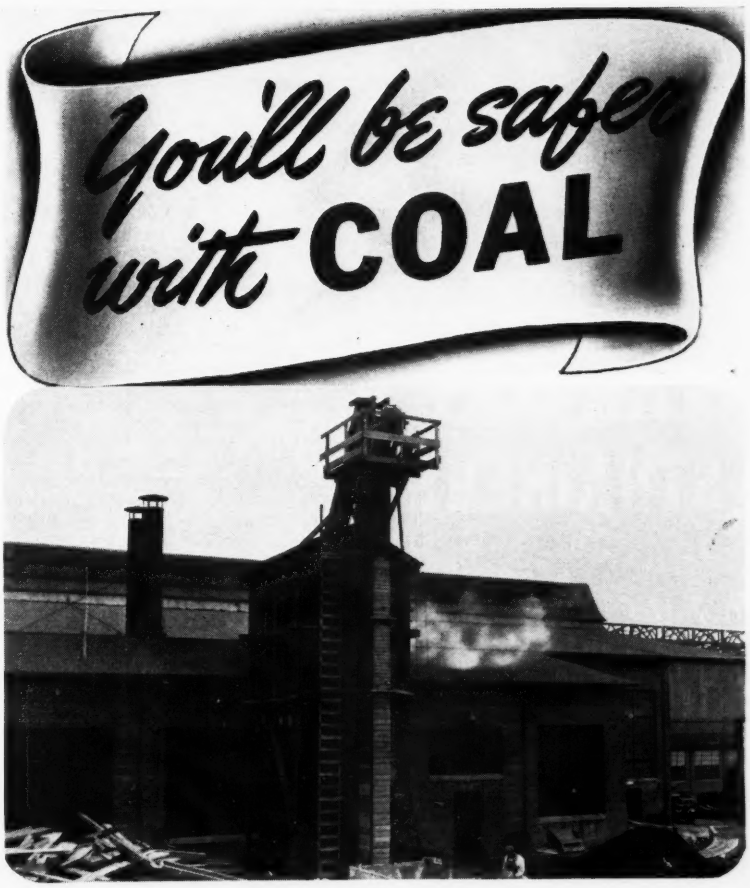
50 **Quick Floor Repairs**—Explanatory folder tells how to apply "Instant Use" in patching broken or rutted floors. Material bonds to feather edge; can be applied over concrete or wood. Flexrock Co.

51 **New Humidifier Handbook**—A new illustrated booklet presenting engineering data and complete details on unit steam-type humidifiers is now available from Armstrong Machine Works. It shows results obtained by automatic humidification for prevention of loss of weight, strength, or quality in hygroscopic materials; for controlling drying processes; for static control to prevent explosion hazard with dust and inflammable liquids and gases; and air conditioning service. Also included are operating features, installation data and other information on these units, which sell for as low as $100 complete for 40,000 cu ft capacity.

52 **Oil Purification Equipment**—Bulletin 100M describes a line of oil purification equipment that will enable you to get maximum production from your machines. Because it is continuous in operation, it removes all types of dirt and contamination. Honan-Crane Corp.

53 **Nickel Alloys Catalog Index**—New Catalog C gives capsule synopsis of available booklets and bulletins on a wide variety of subjects—from industrial applications to metallurgical data and working instructions. The International Nickel Co.

54 **Pipe Cleaning Tools** — Illustrated bulletin describes operating advantages and gives prices of Miller cleaning tools for clogged boiler pipes, waste lines, sewers, drains, etc. J. C. Miller Tool Sales.



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Calculus. By G. E. F. Sherwood and A. E. Taylor. Size 6 by 9 in.; 503 pp; cloth bound. Published by Prentice-Hall, Inc., 70 Fifth Ave., New York, N. Y., 1943. Price $3.75.

Most power engineers get along pretty well in operating work without much knowledge of the calculus. Nevertheless, a knowledge of it, particularly of the subject of integration, is often particularly useful. Designers of both mechanical and electrical equipment, of course, find frequent application of the calculus.

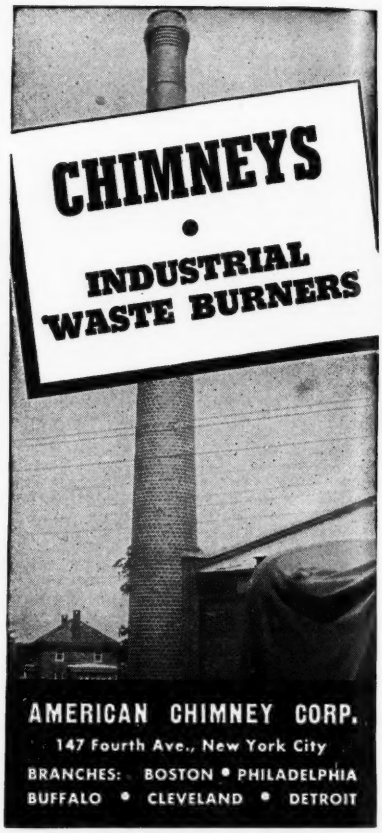
This book, however, is not a general or non-technical discussion of the subject or one for self-instruction. It is rather a true mathematician's textbook for those who want to study the subject in a systematic manner under the guidance of an able teacher. It is designed to give a good understanding of the technique of the calculus and its wide range of application. Attention is paid not only to the mechanical procedures by which problems of differentiation and integration are carried through, but also to the importance of formulating physical or geometrical problems clearly and sharply in mathematical terms. One of the foremost problems for a teacher is that of presenting the subject of limits successfully and the authors of this book have treated this subject with much care and in considerable detail.

The book includes the following chapters: I. Variables, Functions, and the Notion of a Limit; II. The Derivative; III. General Formulas of Differentiation and Algebraic Functions; IV. Applications; V. Differentiation of Transcendental Functions; VI. Differentials; VII. Further Applications; VIII. More About Limits; IX. The Definite Integral; X. Integration; XI. Geometrical Applications of Definite Integrals; XII. Physical Applications of Definite Integrals; XIII. Analytic Geometry of Three Dimensions; XIV. Partial Differentiation; XV. Some Applications of Partial Differentiation; XVI. The Hyperbolic Functions; XVII. Further Methods of Integration; XVIII. Double Integrals; XIX. Triple Integrals; XX. Infinite Series; XXI. Taylor's Series and Taylor's Formula with the Remainder.

In spite of all the popularizations of the calculus, it is usually necessary, in the end, for a man who wants or needs to know the subject to get right down to the thing itself and with the guidance of a good teacher. When he reaches that point, this is the sort of book he must study.

Standards of the Hydraulic Institute-Test Code. Size 8½ by 11 in.; 31 pp; paper bound. Published by the Hydraulic Institute, 90 West St., New York, N. Y., 1943. Price 50 ct.

The object of this test code is to set forth methods under which the performance of centrifugal pumps can be accurately determined when pumping clear water. This code, a revision as of March 1943, superseding the revision of July 1941, contains specific provisions for testing centrifugal pumps to determine whether they meet the guarantee under which they are sold. The code is not intended as a treatise or textbook on how to test centrifugal pumps but is rather a statement of the methods govern-



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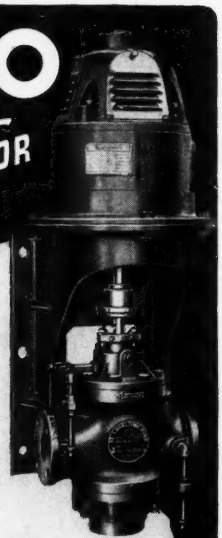

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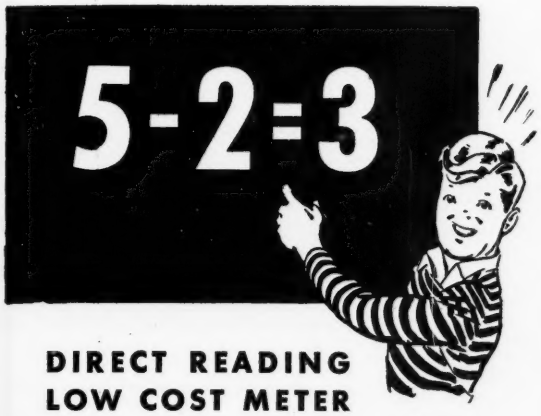

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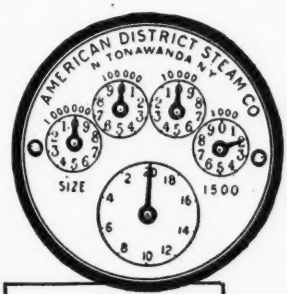

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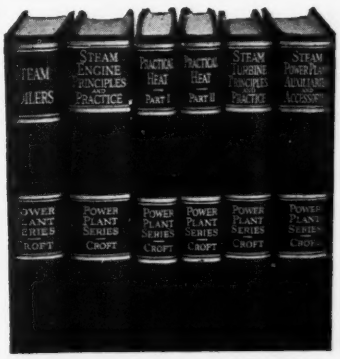

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ing the tests that will give the desired accuracy and a statement of the operating conditions under which the tests shall be made. It is intended to be used by experts in this line of work whose general knowledge of hydraulic engineering should be such as to secure reliable test data by following the methods described.

The book discusses first the scope and meaning and intent of tests, allowances or margins in guarantees, inspection, operating conditions, conduct of test, records and efficiency. This is followed by a discussion of the use of the venturi meter and the weir, also the nozzle, the pitot tube and various types of current meters. Methods of conducting tests and computing results are specified and detailed directions given for the installation of various measuring devices. There is a section on the testing of rotary pumps and another on the testing of reciprocating pumps.

Structural Visualization. By Johnson O'Connor. Size 5½ by 8½ in.; 189 pp; paper bound. Published by Human Engineering Laboratory, 347 Beacon Street, Boston, Mass., 1943. Price $2.00.

This is the most recent of the detailed studies of human aptitudes published by the Human Engineering Laboratory and replaces the book entitled, Characteristics Common To Engineering Executives. As all engineers know, the Human Engineering Laboratory studies human aptitudes, that is, inherent abilities and characteristics, rather than technical knowledge, practical experience and acquired skill. To do this, the Laboratory has developed over a long period of years a number of aptitude tests that aid in determining the fields in which an individual stands the best chance of success.

One of the tests used by the Laboratory is known as the Wiggly Block Test, which engineers of standing solve more quickly than men and women in general. This is doubtless due to the high power of structural visualization possessed by engineers, although it is by no means their exclusive possession. It is the aptitude for picturing in the mind's eye a complete structure with all its details, which may not exist in fact or even in the form of a drawing. As a matter of fact, such visualization must precede the making of a drawing in which the details of the structure are portrayed by white lines on a blueprint in a single plane. While engineers and mechanics have this aptitude to a high degree, it must also be possessed by architects who see in their minds' eye the proposed building shown on the working drawing; by a scientist who sees under the microscope not the entire cell but thin sections and from these builds a three-dimensional concept, by surgeons who delve confidently into solid tissues where an error in depth may mean death.

Measured less accurately than most aptitudes, says Mr. O'Connor, structural visualization holds so significant a role in mechanized civilization that interpretations of results bear heavily on the characteristic. It is none too easy to measure, however, and, of course, is not in itself an absolute criterion, any more than any other single aptitude test. It must be evaluated in relation to a number of the other characteristics possessed by a given individual.

In this book Mr. O'Connor discusses first the entire subject of structural visualization and then its relation to other aptitudes and factors in possible engineering success. Some of these are dexterity, the objective personalty, creative imagination, memory for design, inductive and analytical reasoning, judgment and deductive reasoning, observation, number and tonal memory, general intelligence and the like. The book concludes with a chapter on problem versus job, a discussion of the sizes and types of colleges that should be considered by boys of various aptitudes, and gives a list of publications of the Laboratory, all devoted to the study of aptitudes.

Steel Products Manual—Hot-Rolled Carbon-Steel Bars, Section 8. Size 6 by 9 in., 72 pages; paper bound. Published by American Iron and Steel Institute, 350 Fifth Ave., New York, N. Y., 1943. Price 25 ct.

To give engineers in all fields detailed information about the various iron and steel products they use in their work, the Institute is planning to issue from time to time a steel products manual in various sections, although these will not be in numerical order. New products have brought new terms and practices into use and improvements in old products have changed the precise meaning of terms used to describe them, as well as practices used in their manufacture, testing and inspection. In particular, meanings of some words familiarly used by members of the iron and steel

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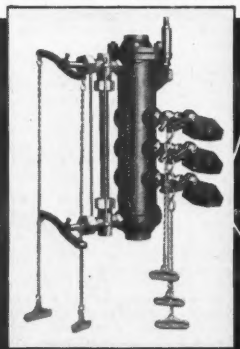

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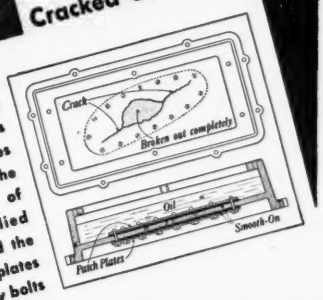

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industry may differ from dictionary definitions of the words, and one of the principal uses of this manual is to provide producers and consumers alike with a common and exact terminology for use in ordering and specifying.

The manual classifies and defines products, presents manufacturing tolerances, gives information on standard methods of inspection and reviews existing specifications in the light of standard practice in the industry.

The present Section 8 presents definitions and manufacturing practices, data on various standard and N. E. carbon steels, non-standard steels, check analyses, methods of sampling, and standard steels subject to physical test. This information is followed by data on manufacturing tolerances, a glossary of manufacturing terms, and information on methods for marking, packaging and loading, and a glossary of packaging and loading terms. An alphabetical index is provided. The above edition is a revision as of June 1943.

Hydraulic Turbine Handbook. By Arnold Pfau. Size 8½ by 11 in.; 66 pp; paper bound. Published by Allis-Chalmers Mfg. Co., Milwaukee 1, Wisconsin, 1943. Copies available without charge on request.

This is one of the most practical discussions of the subject yet published, as might be expected in view of the author's experience in this field. It has been written with the object of combining theory and practice in such a way that they can be readily applied to every-day problems.

The discussion is divided into five parts: I. General Characteristics and Types; II. Theoretical Characteristics; III. Reliability of Service, Speed and Pressure Control; IV. Speed and Pressure Control (Cont.)—Specific Examples; and V. Accessories.

In Part I are discussed the three fundamental requirements determining size and type of hydraulic prime mover. These are the available head, the maximum capacity required or the available flow, the revolutions per minute, and, as a fourth item, the kind of service to be rendered by the unit. The principal types of hydraulic prime movers, that is the Pelton, the Francis and the propeller types, are discussed in the light of the three foregoing fundamentals.

In Part II, the theoretical characteristics of each of the three types are discussed both in general and mathematical terms. Both Parts I and II are well illustrated with photographs of typical units and diagrams showing their operation, characteristic curves and the like.

In Part III, reliability under mechanical wear, reliable accessories, safety in operation and reliability and quality of service are discussed. This is followed by a detailed treatment of speed control, including sensitiveness of governing equipment, calculation of speed change, variable head, water hammer, and auxiliary relief of pressure regulators.

Part IV, giving specific examples of speed and pressure control, includes tables and diagrams as well as computations for specific cases. Part V on accessories discusses typical intake and pipe line designs, treatment of surge reservoirs, valves, and tailrace gates.

The Tennessee Valley Authority. By C. Herman Pritchett. Size 6½ by 9 in.; 333 pp; cloth bound. Published, 1943, by The University of North Carolina Press, Chapel Hill, N. C. Price $3.50.

To those who have always considered the Tennessee Valley Authority to be nothing but a Socialistic device whereby the Federal Government could develop large amounts of hydroelectric power and compete with the private utilities in that field. this book will provide an entirely new point of view. Its major emphasis is upon the development as a whole and its administrative achievements, in their way as spectacular as the dams and power houses.

The author, now assistant professor of political science at the University of Chicago, was an employee of the TVA Social and Economic Division from 1934 to 1937 and he has first-hand knowledge of his subject.

He discusses the background of the TVA, its multiple-purpose program, its development as one of the greatest power agencies in the world, the many problems and opportunities which stemmed from its character as a government-owned corporation, its relation to other governmental agencies and to Congress and the President, its dynamic personnel program, its role as a regional planner, its stormy career in the courts, its contribution to the war effort, and its ultimate meaning and significance.

He affords an insight into the nature and magnitude of the administrative problems encountered, and the farsighted manner in which these problems were met.

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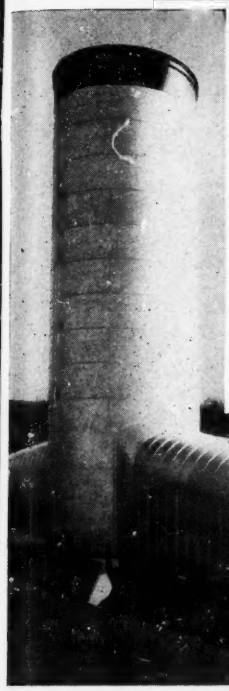

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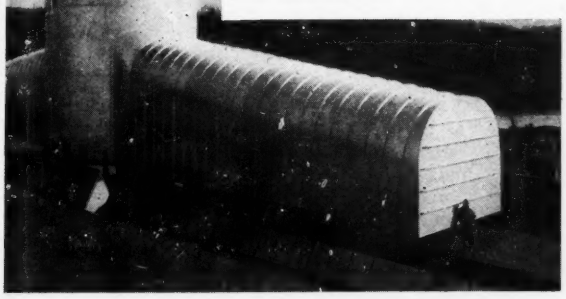

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Mechanical World Year Book and Electrical Year Book, 1943. Size 4½ by 6 in., cloth bound. Published by Emmott & Co., Ltd., 78 Palatine Road, Manchester, 20, England. Price 2/6 net, each.

Despite the difficulties of publication in Great Britain under present conditions, the 1943 editions of these two well-known and standard year books have been issued. As their prefaces point out, there is greater need than ever during the war for certain types of information vital to the successful and continuous operation of British industry and these books have attempted very successfully to present it for ready reference. The smaller size pages and lighter weight paper used reflect some of the British publishing difficulties.

In the Mechanical World Year Book an entirely new section on the light metals and alloys has been included and recent data have been inserted in the tables of speeds and feeds of cutting tools.

The book contains data, all applying to British practice only, on export credits guarantee department, price and decimal equivalents, conversion tables, weights and measures, hydraulic equivalents, displacement table, pressure and head of water, weight and specific gravity of miscellaneous solids, brassfounders' metal mixtures, selected British standard mechanical specifications and the like. This is followed by chapters on the light alloys, selection and substitution of production processes, die casting, plastics, ball and roller bearings, steam boilers, and combustion, boiler mountings, fittings and instruments, and a large amount of information on metallurgy, gears, and standard shop practice. Tables of areas, decimal equivalents, squares, cubes and roots and the like and log tables are given at the end.

The Electrical Year Book, following an introductory section of tables, gives chapters on general electrical principles, magnetic materials, insulation, alternating current systems, symmetrical components, condenser calculations, generation of electricity, motors in industrial service, dynamo and motor defects, transformers and converting plants, control gear, switchboards and switchgear, storage batteries, illumination, conductors and meters.

Mechanical Vibrations. By R. K. Bernhard. Size 6 by 9 in.; 139 pp; cloth bound. Published by Pitman Publishing Corp., 2 West 45th St., New York, N. Y., 1943. Price $3.00.

This book, according to the author, is not intended to give a complete treatment of the subject of mechanical vibration, for this requires an extensive application of higher mathematics. It is intended, however, to give students and practicing engineers who have not studied dynamics and who are interested in mechanical vibration, a sound introduction to this important field of engineering science.

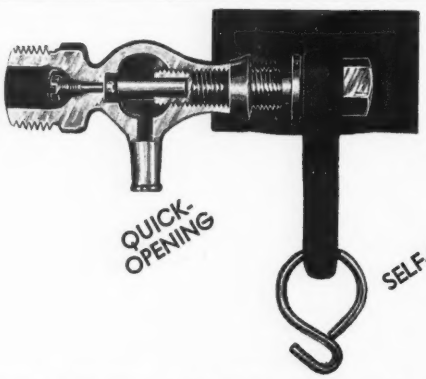
This field is important and becoming increasingly so, because the trend of our present engineering development is toward increasing speeds and heavier loads, involving higher dynamic stresses caused by increased mechanical vibration.

Although this book does not require a knowledge of higher mathematics, it does require some acquaintance with ordinary algebra and trigonometry, particularly in connection with the discussion of harmonic vibrations. However, the book begins with a simple, non-mathematical discussion of the physical phenomena of vibration—that is, the forces that cause it and how and why they cause it—and then progresses to details of the methods for measuring vibration.

Part I on physical phenomena discusses: general definitions; observation of harmonic vibrations in simple phenomena; girder and measuring instrument considered as simple pendulum; damping; forced vibrations; diagram of an instrument considered as result of forced vibrations; usefulness of mechanical instruments; discussion of vibration phenomena due to forced vibrations; coupled vibrations; superposition of harmonic vibrations, and harmonic analysis; and resonance effect of girders.

Part II takes up magnitudes and limits of quantities to be measured, requirements for measuring instruments, sources of errors, calibration of instruments, typical dynamic recording instruments and other methods. There is a summary of practical applications, a bibliography of books and articles on the subject and an index.

The book is very well illustrated with practical diagrams and charts and in the section on measuring instruments there are detailed drawings and photographs of the various devices used, such as the mechanical vibrograph, the stroboscope, the cathode-ray oscillograph and other electrical and electromagnetic devices.



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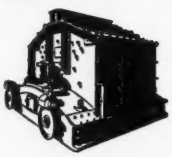

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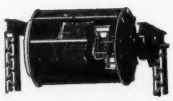

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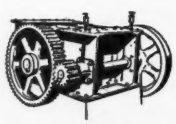

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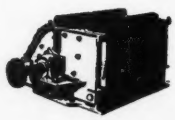

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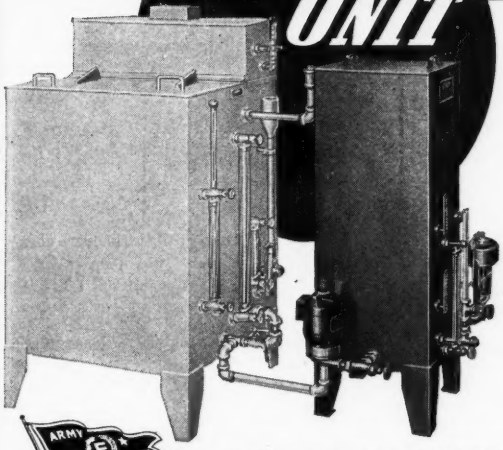

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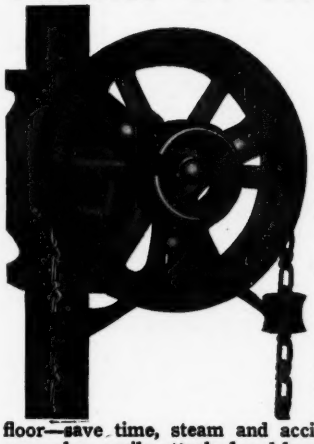

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Power Plant Construction News

Ala., Gadsden—Goodyear Tire & Rubber Co., plans installation of electric power equipment in new one and multi-story addition to local mill, totaling about 250,000 sq ft of floor space, reported to cost over $3,500,000. A new power plant will be constructed at mill to cost about $400,000. Contract for latter building has been let to Rust Engineering Co., Liberty Life Building., Birmingham, Ala. Entire project has a priority rating. Main offices of company are at Akron, Ohio.

Calif., Burbank—Vega Aircraft Corp., 2555 North Hollywood Way, plans installation of electric power equipment in new additions to plant for production for Government, comprising several one-story structures, estimated to cost about $3,450,000. Financing in that amount will be provided by Defense Plant Corp., Washington, D. C., Federal agency.

Calif., Cutler—Calgro Winery Co., Cutler (Tulare County) plans installation of electric power equipment in connection with proposed rebuilding of portion of plant recently destroyed by fire. Loss reported over $450,000. Proposed to make application for priority ruling at early date.

Conn., Stratford—United Aircraft Corp., Chance-Vought Division, 550 Main St., has completed plans for addition to boiler room, about 45 x 50 ft, and will begin work at once. Cost reported over $65,000, with equipment. Albert Kahn, Inc., New Center Bldg., Detroit, Mich., is architect and engineer.

Ga., Dublin—Navy Department, Washington, D. C., will take bids soon for new naval hospital near Dublin, to include power plant, mechanical laundry, refrigeration plant and other service buildings. Project will include underground conduit lines and other electrical facilities. Cost estimated close to $5,000,000. Robert & Co., Bina Allen Bldg., Atlanta, Ga., are engineers. Bureau of Yards and Docks, Navy Department, Washington, in charge.

Ill., Chicago—Seymour & Peck Co., 921 West 20th Pl., manufacturer of veneer drums for shipping service, plans installation of electric power equipment in connection with proposed rebuilding of portion of plant, recently destroyed by fire with loss reported over $100,000.

Iowa, Des Moines—Hargrove Co., Fourth and Newport Sts., manufacturer of farm machinery and implements, plans installation of electric power equipment in connection with proposed rebuilding of portion of plant, recently destroyed by fire, with loss reported close to $100,000, including machinery. Proposed to secure a priority rating. George Hargrove is president.

Mich., Gladstone—Marble Arms & Mfg. Co., manufacturer of hunting and fishing equipment, is considering early rebuilding of power house at plant, recently destroyed by fire. An official estimate of loss has not been announced.

Mich., Ironwood—City Commission has approved a postwar project for a municipal electric power plant, estimated to cost about $1,000,000, with turbine-generators, boilers and auxiliary equipment. Proposed to call a special election in near future to authorize bond issue in that amount.

Mich., Port Huron—Mueller Brass Co., Port Huron, manufacturer of brass and copper tubing, rods and kindred products, plans installation of electric power equipment in new addition to plant for production for Government. Cost estimated about $1,500,000, with financing provided by Defense Plant Corp., Washington, D. C., Federal agency. Austin Co., 16112 Euclid Ave., Cleveland, Ohio, and Curtis Bldg., Detroit, Mich., is engineer and contractor.

Minn., Minneapolis—Northwestern Aeronautical Corp., Wold-Chamberlain Airport, manufacturer of glider-type aircraft, plans installation of electric power equipment in proposed additions to plant for increased capacity for Government. Cost estimated about $800,000, with financing provided in that amount by Defense Plant Corp., Washington, D. C., Federal agency.

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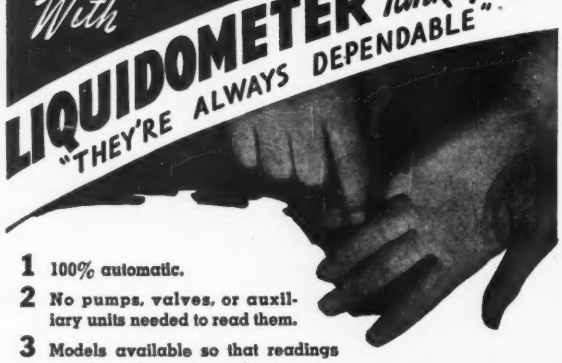

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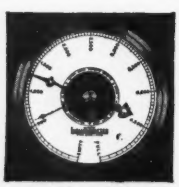

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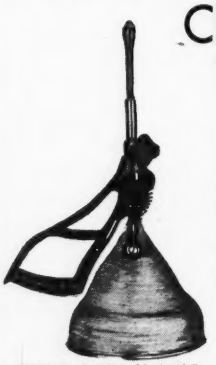

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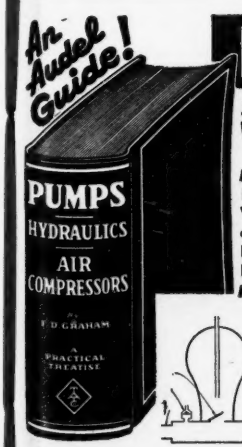

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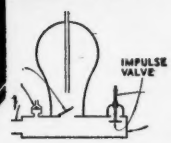

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Mo., St. Louis—Board of Public Service, City Hall, Charles H. Ellaby, president, is arranging a postwar project for extensions and improvements in municipal water system, including installation of new boilers and auxiliary equipment in power house at Chain of Rocks pumping station. Also, installation of new high-service pumping machinery with accessories. Entire project is estimated to cost over $1,500,000.

Mo., Washington—War Department plans installation of new water-softening plant for municipal waterworks, as a postwar project. Board of City Commissioners will have estimates of cost prepared in near future.

N. J., Oxford—Alan Wood Steel Co., Oxford, plans installation of electric power equipment in connection with expansion in local iron ore mining properties and concentrating plant for production for Government. Cost estimated about $875,000, with financing provided in that amount by Defense Plant Corp., Washington, D. C., Federal agency. Main offices of company are at Conshohocken, Pa.

N. Y., Bainbridge—New York State Electric & Gas Corp., Ithaca, is reported planning new steam-electric generating station in vicinity of Bainbridge, to cost about $2,000,000, with equipment. Also will build transmission line for connection with present high-tension system. It has not been officially announced whether project is a postwar development or will be carried out at present time. Gilbert Associates, Inc., 412 Washington St., Reading, Pa., is consulting engineer.

Ohio, Cleveland—Warren Refining & Chemical Co., 9420 Meech St., manufacturer of processed oils, lubricants, polishes, etc., plans installation of electric power equipment in connection with proposed rebuilding of portion of plant, recently destroyed by fire. Loss reported over $150,000.

Ohio, Cleveland—Wellman Bronze & Aluminum Co., 2525 East 93rd St., has plans under way for new boiler house at plant, including coal storage facilities and smoke stack. Cost reported about $75,000, with equipment. Financing will be provided by Defense Plant Corp., Washington, D. C., Federal agency. Frank Haushka, Ninth-Chester Bldg., Cleveland, is architect and engineer.

Pa., Philadelphia—Wilkening Mfg. Co., 2000 South 71st St., manufacturer of piston rings and kindred products, plans extensions in plant for increased output for Government, with installation of machinery and electric power equipment. Cost estimated about $100,000, with financing in that amount provided by Defense Plant Corp., Washington, D. C., Federal agency. Work will be carried out soon.

S. D., Ardmore—Wesley N. Bayer, operating local power plant for service in this community, plans rebuilding a portion of station, recently damaged by fire. No official estimate of loss announced. Proposed to arrange financing through local subscriptions.

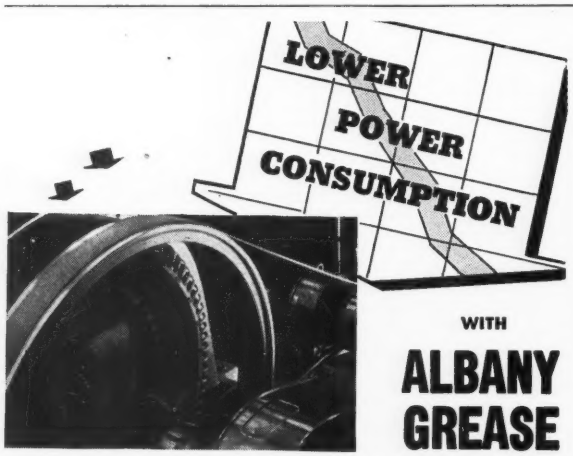
Tenn., Memphis—Memphis Light, Gas & Water System, City Hall, has plans for extensions in power substation on Poplar Ave., with installation of additional capacitators and other equipment, estimated to cost close to $125,000. Project has been approved and work will be carried out soon.

Texas, Fort Worth—Consolidated-Vultee Aircraft Corp., Grants Lane, plans installation of electric power equipment in new one-story addition, to be used primarily as an experimental works. Cost reported about $1,200,000. Work on superstructure will begin soon. Project will be financed by Defense Plant Corp., Washington, D. C., Federal agency.

Va., Radford—Department of Public Utilities, 98 First St., plans construction of new steam-electric generating plant as a postwar project, to be equipped for initial capacity of 2500-kw, reported to cost close to $400,000, with equipment and line extensions. Proposed station will be operated in conjunction with present municipal power plant.

Wash., Spokane—Washington Water Power Co., 825 Trent Ave., has plans for new power substation on Wellesley Ave., for service in northern part of city. Application has been made for permission. No estimate of cost announced.

Wis., Waukesha—General Malleable Corp., Waukesha, manufacturer of aluminum and other light metal castings, plans installation of electric power equipment in connection with expansion in plant for production for Government, including additional building. Entire project will cost about $600,000, and will be financed by Defense Plant Corp., Washington, D. C., Federal agency.



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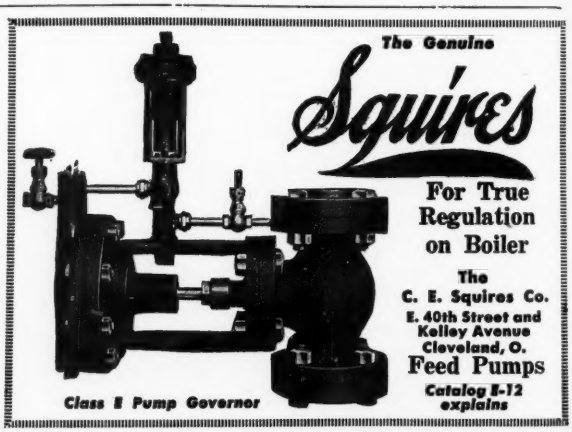

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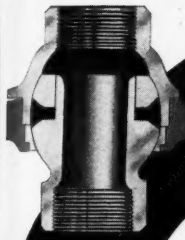

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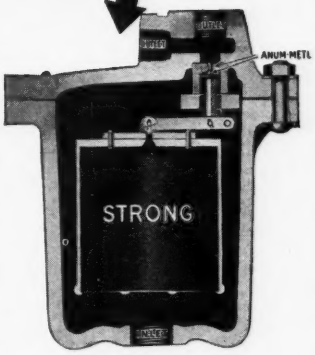

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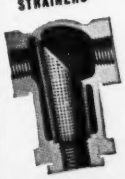

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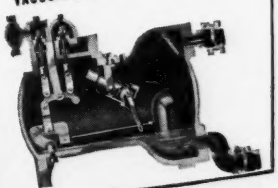

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Advertisers

Airetool Mfg. Co. ..... *
Air Preheater Corp., The.....175
Aldrich Pump Co., The.....169
Allis-Chalmers Mfg. Co. 26-27, 177
Allpax Co., Inc., The.....168
American Blower Corp. 28-29
American Chain & Cable Co., Inc...143
American Chimney Corp. 194
American Coal Burner Co. 162
American District Steam Co. 195
American Engrg. Company 38-39
American Pulverizer Co. ..... *
American Radiator & Standard Sanitary Corp. 28-29
American Water Softener Co., The *
Anderson Co., The V. D. ..... *
Anderson-Stolz Corp. 170
Arkansas Fuel Oil Co. ..... *
Armor-Clad Company 188
Armstrong Machine Works..16-17, 184
Atlas Valve Co. ..... *
Audel & Co., Theo. 203

Babbitt Steam Specialty Co. 201
Babcock & Wilcox Co., The.....42-43
Babcock & Wilcox Tube Co., The... *
Bacharach Ind. Inst. Co. ..... *
Bailey Meter Co. 12-13
Baldwin De La Vergne Sales Corp. .127
Baldwin-Hill Co. 140, 148
Baldwin Locomotive Works.....127
Beaumont Birch Company.....176
Belmont Packing & Rubber Co., The 46
Bendix Aviation Corp. 178
Betz, W. H. & L. D. 121
Biddle Co., James G. 37
Bird-Archer Co., The..... *
Blackmer Pump Co. ..... *
Bowser, Inc. 201
Brickseal Refractory Co. 184
Brown Instrument Co., The..... 55
Brown-Strauss Corp. ..... *
Brunt Equipment Co. ..... *
Builders-Providence, Inc. 60
Burgess Battery Co. 125
Busch-Sulzer Bros.-Diesel Engine Co.179

Canton Stoker Corp. ..... *
Cash Company, A. W. ..... *
Chapman Valve Mfg. Co., The.....
.....Inside Back Cover
Chesterton Co., A. W. 164, 172
Cities Service Oil Co. ..... *
Cochrane Corporation 58, 186
Combination Pump Valve Co. ..... *
Combustion Engrg. Co., Inc. 32-33
Combustion Equip. & Insulation Co..166
Condenser Service & Engineering Co., Inc. 54
Connery Construction Co. 199
Consolidated Equipment, Inc. ..... *
Cook's Sons, Inc., Adam.....204
Coppus Engrg. Corp. ..... *
Corning Glass Works..... *
Crane Co. 115
Crane Packing Co. ..... *
Cutler-Hammer, Inc. .....Back Cover

Dampney Company of America, The.163
Dart Mfg. Co., E. M. 146
Davis Regulator Co. 197
Dearborn Chemical Co. ..... *
DeLaval Steam Turbine Co. 34, 194
Detrick Co., M. H. 159
Detroit Stoker Co. 20-21
Dowell Incorporated 9

Edge Moor Iron Works, Inc. ..... *
Edward Valve & Mfg. Co., Inc., The.113
Electric Chemical Co. ..... *
Elgin Softener Corp. 52
Elliott Co. 2-3
Emsco Equipment Company..... *
Engineer Co., The.....190

Fairbanks Co., The.....141
Fairbanks, Morse & Co. 151
Fischer & Porter Co. ..... *
Fisher Governor Company..... *
Flexrock Co. 201
Flynn & Emrich Co., The..... *
Foster Engrg. Company.....136
Foster Wheeler Corp. 30-31
France Packing Co., The.....188
Fuller Company ..... *

Garlock Packing Co., The..... *
Garratt-Callahan Co. 198
General Electric Co. 45, 47
Gifford-Wood Co. 193
Gilmer Company, L. H. ..... *
Globe Steel Tubes Co. 134
Goetze Gasket & Packing Co., Inc. .. *
Golden-Anderson Valve Specialty Co.119
Graver Tank & Mfg. Co., Inc. ..... *
Griscom-Russell Co., The.....161

Haering & Co., Inc., D. W. 182
Hagan Corporation 18-19, 40-41
Haines & Co., William S. ..... *
Hall Laboratories, Inc. 18-19, 40-41
Hays Corporation, The.....117
Hendy Iron Works, Joshua.....173
Henszey Company 144
Hercules Float Works.....203
Honan-Crane Corp. 196
Huyette Co., Inc., The Paul B. 200

Infilco, Incorporated ..... *
International Nickel Co., Inc., The. *
Iron Fireman Mfg. Co. 61

Jenkins Bros. 135
Johns-Manville ..... *
Johnson Service Company.....149

Kellogg Co., The M. W. ..... *
Kennedy Valve Mfg. Co., The.....137
Kieley & Mueller.....203

Ladish Drop Forge Co. ..... *
Leavitt Machine Co. ..... *
Leeds & Northrup Company..... 44
Link-Belt Co. ..... *
Liquidometer Corp., The.....202
Lummus Co., The..... 56
Lunkenheimer Co., The.....111

Macwhyte Company 57
Magnolia Metal Co. ..... *
Manzel Bros. Co. 203
Marley Company, Inc., The..... 51
Martindale Electric Co., The.....160
Maxim Silencer Company, The..... *
McAlear Manufacturing Company..189
McGraw-Hill Book Co., Inc. 195
Mercoid Corp., The..... *
Midwest Piping & Supply Co., Inc..153
Miller Tool Sales, J. C. 202
Minneapolis-Honeywell Regulator Co. 55
Murray Iron Works Co. 174

National Aluminate Corp. 109
National Valve & Mfg. Co. 130
Nicholson & Co., W. H. 182
Northern Equipment Co. 129
Norton Company ..... *

Oakite Products, Inc. 186

Peabody Engrg. Corp. 187
Pennsylvania Crusher Co. 200
Permutit Co., The..... *
Philadelphia Gear Works.....131
Pipe & Tube Products, Inc. 166
Pomona Pump Co. ..... *
Porter Co., Inc., H. K. 178
Porter & Co., Inc., H. W. ..... *
Powell Co., The Wm. 132
Prat-Daniel Corp. ..... *
Pressure Concrete Co. 180
Pritchard & Co., J. F. 181

Quaker Rubber Corporation..... *
Quimby Pump Co., Inc. 178

Randolph Laboratories, Inc. 157
Raybestos-Manhattan, Inc. 152
Reading-Pratt & Cady Div. of American Chain & Cable Co., Inc. 143
Ready-Power Co., The..... *
Reliance Gauge Column Co., The...196
Rempe Co. ..... *
Republic Flow Meters Co. 50
Richardson Scale Company..... *
Ric-Wil Company, The.....183
Roto Company, The.....168
R-S Products Corp. 138

Sarco Company, Inc. 53
Scovill Mfg. Co. ..... *
Shell Oil Co., Inc. 24-25
Simplex Valve & Meter Co..... *
Sims Company, The.....176
Skinner Engine Co. 185
Smooth-On Mfg. Co. 197
Socony-Vacuum Oil Co., Inc. 15
Springfield Boiler Co. ..... *
Squires Co., The C. E. 204
Standard Oil Co. (Indiana).....35-36
Steel Improvement & Forge Co. .... *
Stephens-Adamson Mfg. Co. 59
Strong, Carlisle & Hammond Co. ...205
Superior Railway Products Corp. ..205
Sun Oil Company..... *
Swartwout Co., The.....180
Syntron Company ..... *

Talon, Inc. 6
Taylor & Co., W. A. ..... *
Taylor Forge & Pipe Works.....139
Terry Steam Turbine Co., The..... 14
Texas Co., The..... 4
Tide Water Associated Oil Co....48-49
Todd Shipyards Corp. 167
Tomlee Tool & Eng'r'g Co. 22-23
Treasury Department 150
Troy Engine & Machine Co. 171
Tube-Turns, Inc. 123

Union Iron Works.....156
United States Rubber Co. 155

Viking Instruments, Inc. 190
Vogt Machine Co., Inc., Henry.....145

Warren Steam Pump Co., Inc. 142
Water Treatment Co. of America...154
Watson-Stillman Co., The.....199
Westinghouse Elec. & Mfg. Co. 133
Wickes Boiler Co., The.....204
Williams Gauge Co., The..... *
Williams Valve Co., The D. T. 198
Wilson, Inc., Thos. C. 158
Wing Mfg. Co., L. J. ..... *
Worthington Pump & Machy. Corp. 147, 165

Xzit Sales Corp. ..... *

Yarnall-Waring Co. 10-11, 62, 194

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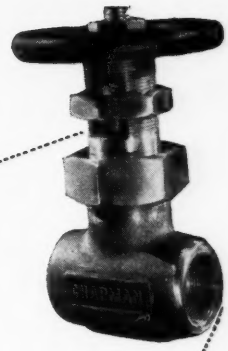

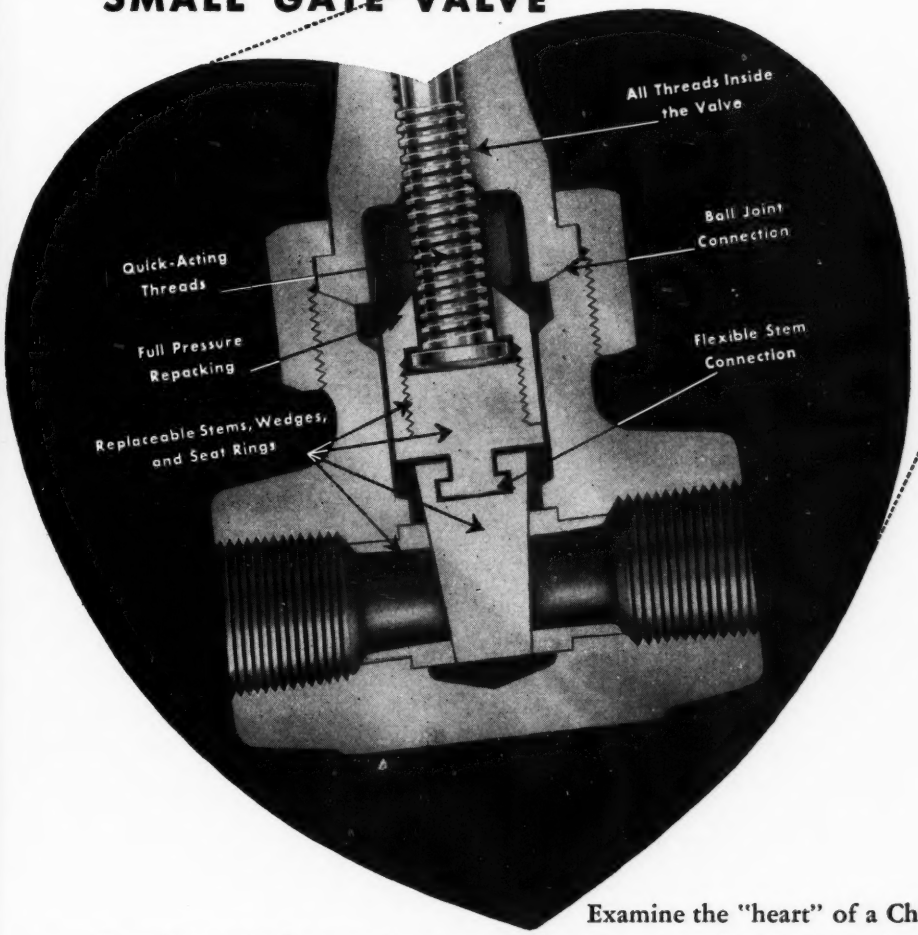

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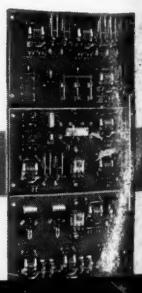

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